MECHANICAL ENGINEERING

April 1956

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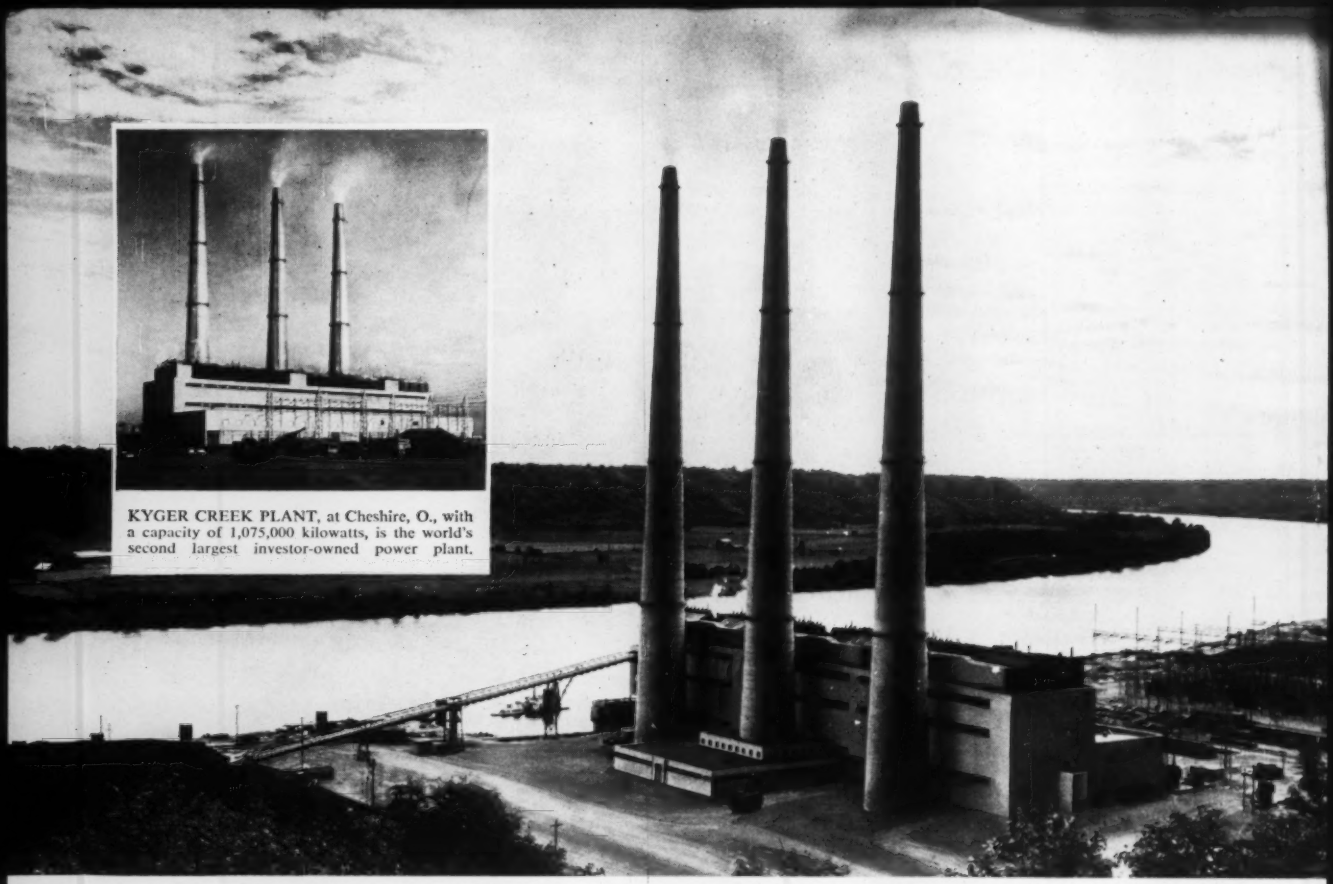
ASME Semi-Annual Meeting • Cleveland, Ohio • June 17-21, 1956



KYGER CREEK PLANT, at Cheshire, O., with a capacity of 1,075,000 kilowatts, is the world's second largest investor-owned power plant.

CLIFTY CREEK PLANT, at Madison, Ind., with a capacity of 1,290,000 kilowatts, is the world's largest investor-owned power plant.

THE MIRACLE ON THE OHIO RIVER

On the banks of the Ohio, right now, these two huge electric plants are turning out power at the rate of over 18-billion kilowatt-hours annually. They are, respectively, the first and second largest investor-owned power plants in the world. They stand on what was farmland less than three and one-half years ago.

Their completion, substantially ahead of schedule, is the result of the outstanding teamwork of management, investors, engineers, technicians and workers in privately-owned utilities and their suppliers.

The vast power output of these plants, *almost half as much electricity as all France produces,* is ready to assure uninterrupted operation of the Atomic Energy Commission's uranium diffusion center near Portsmouth, Ohio.

When the AEC made its enormous needs known, 15 private electric companies* joined forces to form the Ohio Valley Electric Corporation and its subsidiary, Indiana-Kentucky Electric Corporation. In quick order the 11 gigantic B&W boilers, the turbines, generators, buildings—and all the vast complex of auxiliary equipment—were designed, built and placed into operation.

The first generating units went "on the line" in February 1955. The final unit was put in service in February 1956 at Clifty Creek, marking the largest installation of power in a single project ever made in a 12-month period.

All Americans can be proud of OVEC-IKEC for this great accomplishment. What appears to be a miracle is, in reality, a clear demonstration of what private enterprise and enlightened government, working together, can accomplish for the benefit of the entire nation.

The future will undoubtedly pose many similar challenges. Can they be met? Babcock & Wilcox, like so many other American firms, is pledging its resources in extensive manpower and engineering development programs to guarantee that the answer will be "Yes!"

The Babcock & Wilcox Company, 161 East 42nd Street, New York 17, N. Y.

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*Subsidiary of American Gas and Electric Co. **Subsidiary of The West Penn Electric Co. ***Subsidiary of Ohio Edison Co.

BABCOCK & WILCOX

BOILER DIVISION

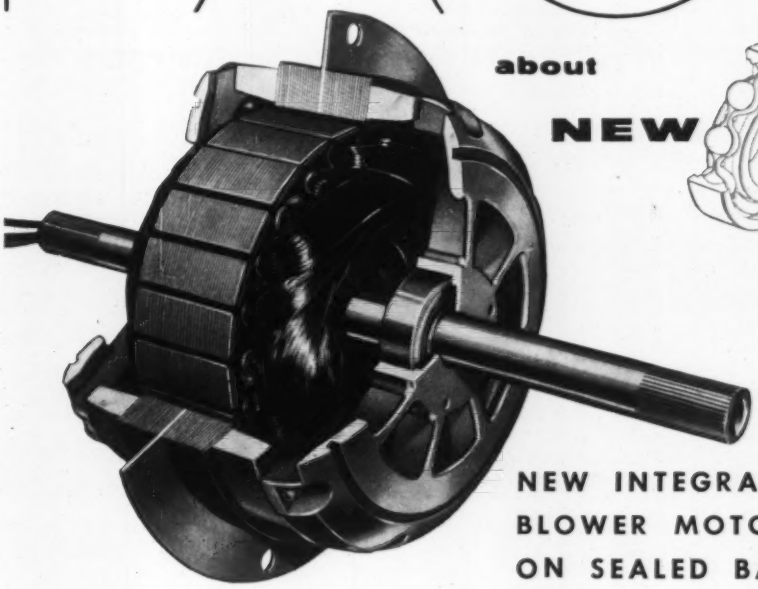
N-210

FACTS

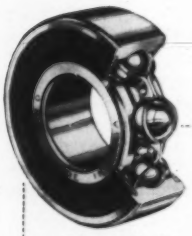
about

NEW DEPARTURE

BALL BEARINGS



NEW INTEGRAL-DRIVE BLOWER MOTOR DEPENDS ON SEALED BALL BEARINGS!



5 advantages of New Departure's Sentri-Seal ball bearings in electric motor applications

- **SEALED AND LUBRICATED FOR LIFE!** No need for relubrication; no danger of over- or under-lubrication.
- **SIMPLIFY DESIGN!** Eliminate need for separate seals and grease fittings.
- **CARRY LOADS IN ANY POSITION!** Moving parts are held in positive alignment, regardless of motor mounting position.
- **WEAR IS NEGLIGIBLE!** Require no attention for adjustment for wear. Have a reputation for outlasting the products they serve.
- **QUIET-RUNNING!** New Departure ball bearings are precision-made, run smoothly. Their uniformity is a guarantee of dependability.

Nowhere is the superiority of New Departure sealed ball bearings in electric motor applications better exemplified than in this new integral-drive blower motor.

Revolutionary "inside-out" design of this new motor imposed a lubrication problem solved by the permanent-lubrication characteristic of the finest sealed ball bearings. In this motor, the rotating element, to which the blower wheel is attached, is on the outside and revolves around a stationary shaft through which the lead wires pass. "Sealed and lubricated-for-life" New Departure ball bearings were selected because they assure permanent lubrication, regardless of centrifugal force. Also, because motor and blower wheel share the same permanently lubricated bearings, this integral unit is free of the need for periodic servicing.

Equally important, New Departure sealed ball bearings handle combination loads in any position . . . assure positive alignment of rotor and stator. This means a versatility of application for this motor that offers new freedom to designers.

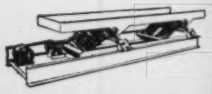
Sealed ball bearings also help increase motor efficiency and reduce electrical hum. Since in ball bearings wear is so slight as to be entirely negligible, designers were able to build in a smaller precision air gap, which is maintained throughout motor life.

Let New Departure's unexcelled engineering service show you the many advantages of sealed ball bearings in electric motor and other applications.

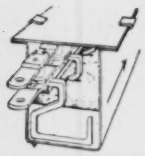
NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONN.

MECHANICAL ENGINEERING, April, 1956, Vol. 78, No. 4. Published monthly by the American Society of Mechanical Engineers, at 20th and Northampton Sts., Easton, Pa. Editorial and Advertising departments, 29 West 39th St., New York 18, N. Y. Price to members $3.50 annually, single copy 50¢; to nonmembers $7.00 annually, single copy 75¢. Add $1.50 postage to all countries outside the United States, Canada, and the Pan-American Union. Entered as second-class matter December 21, 1920, at the Post Office at Easton, Pa., under the Act of March 3, 1879. Member of the Audit Bureau of Circulations.

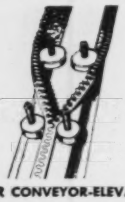
BELT CONVEYORS



VIBRATING CONVEYORS

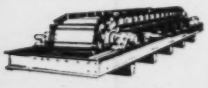


REDLER CONVEYOR-ELEVATOR



ZIPPER CONVEYOR-ELEVATORS

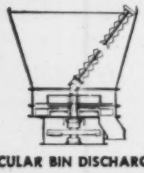
BUCKET ELEVATORS



PAN CONVEYORS

VIBRATING SCREENS

BIN GATES—ALL KINDS

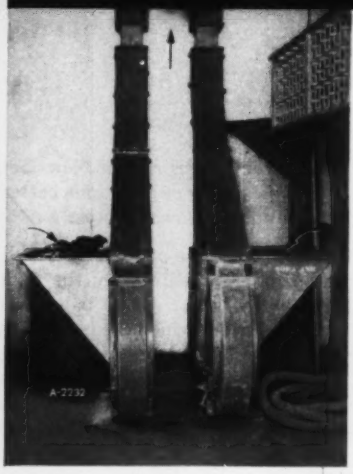


CIRCULAR BIN DISCHARGERS

SEALMASTER BALL BEARING UNITS

LIME and SODA ASH *ON THE DOUBLE!*

S-A REDLER CONVEYOR ELEVATOR SYSTEM provides water treatment for Village of Clyde

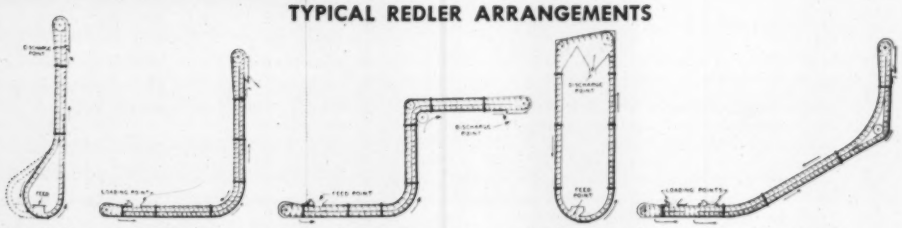


The municipal water treatment plant at the Village of Clyde, Ohio, contains twin S-A Redler loop boot vertical and horizontal conveyors for delivery of hydrated lime and soda ash.

Inherently economical, this type Redler requires no boot pit since loading point is only slightly above floor level. Furthermore, no special feeding apparatus is needed. Bulk materials which have a tendency to aerate are fed to the return side of conveyor loop. A seal in the load is thereby created, permitting material to move smoothly and in a solid column to point of discharge. Minimum space requirements for this S-A system is an important factor in small plant installation.

As was true at Clyde, simple adaptations of standard S-A conveyor products very often provide extremely low cost and efficient bulk material handling. In fact, Stephens-Adamson's wide product range and versatility can often provide a conveying system that is virtually "in stock."

TYPICAL REDLER ARRANGEMENTS



Loop Boot Elevators | L-Type Elevator-Conveyor | Z-Type Elevator-Conveyor | Vertical Closed Circuit Elevator | Special Elevator-Conveyor

FREE BULLETINS AVAILABLE ON ALL THESE PRODUCTS

STEPHENS-ADAMSON MFG. CO.

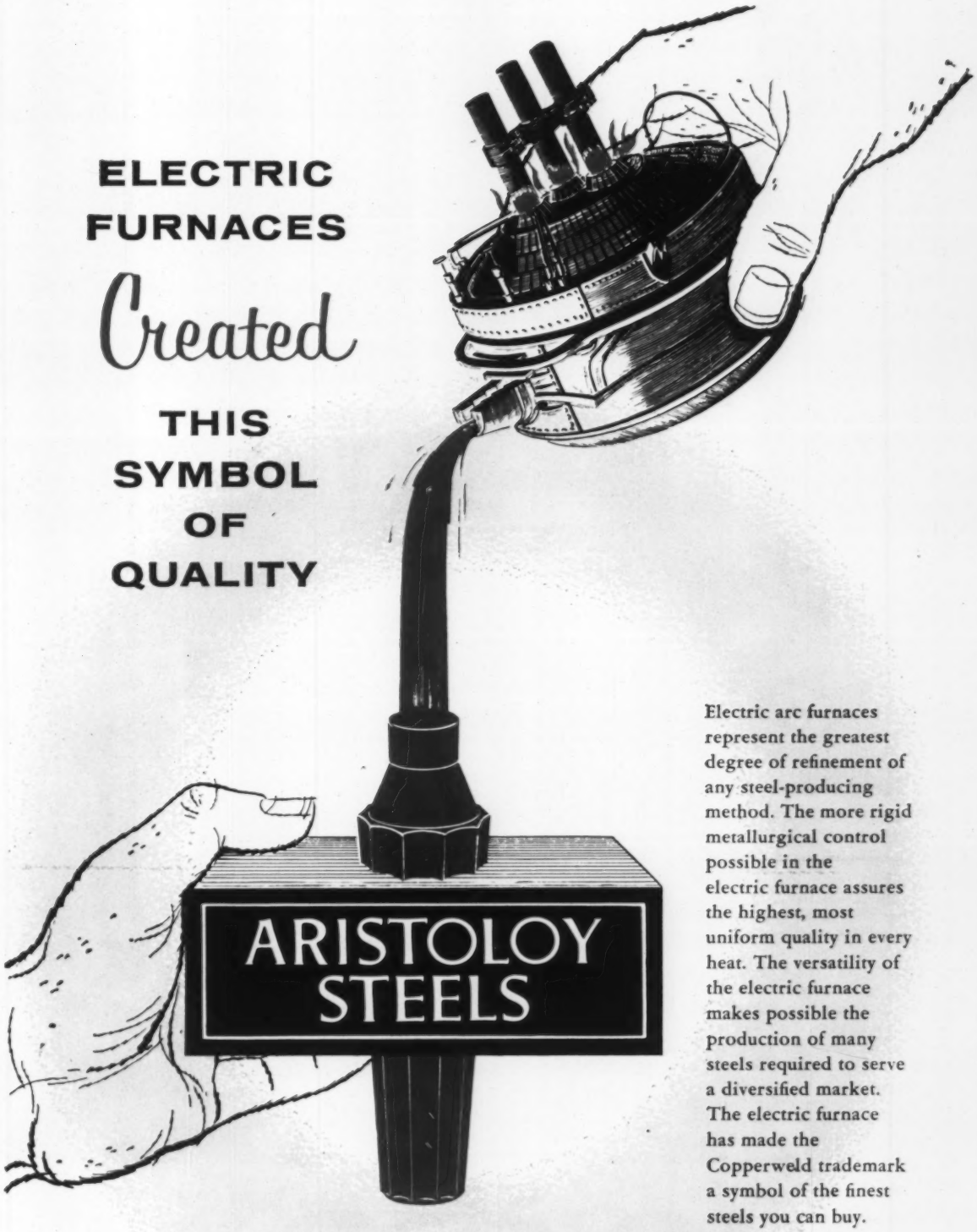
19 Ridgeway Ave., Aurora, Ill.—Los Angeles, Calif.—Belleville, Ontario.

ENGINEERING DIVISION
Designers and manufacturers of all types of bulk materials conveying systems.

STANDARD PRODUCTS DIVISION
A complete line of conveyor accessories—centrifugal loaders—car pullers—bin level controls, etc.

SEALMASTER DIVISION
A full line of industrial ball bearing units available in both standard and special housings.

ELECTRIC FURNACES *Created* THIS SYMBOL OF QUALITY



Electric arc furnaces represent the greatest degree of refinement of any steel-producing method. The more rigid metallurgical control possible in the electric furnace assures the highest, most uniform quality in every heat. The versatility of the electric furnace makes possible the production of many steels required to serve a diversified market. The electric furnace has made the Copperweld trademark a symbol of the finest steels you can buy.

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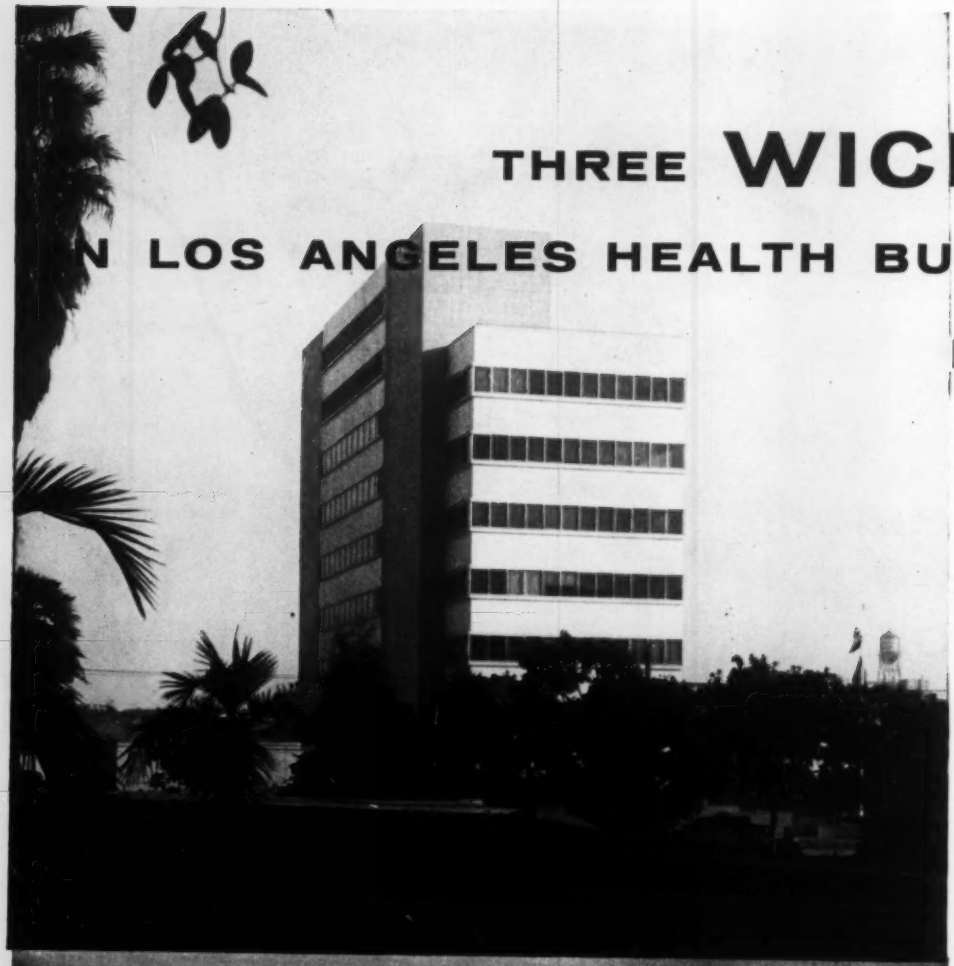
THREE WICKES

N LOS ANGELES HEALTH BUILDING

IS THE



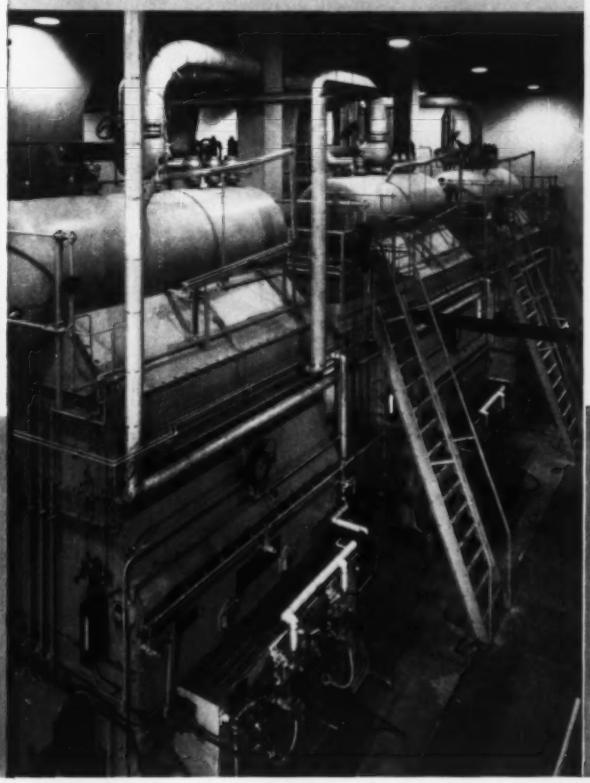
Architects: Lunden, Hayward, and O'Connor
Builder: Robert E. McKee General Contractor, Inc.

Housed in the striking modern structure shown here is a new clinic and health center for the city of Los Angeles Health Department. Beautifully equipped in every respect, the building has individual room thermostats to insure the exact desired temperature in each separate area . . . clinics, laboratories, medical sections, and others. To insure that the heating system responds immediately to these controls, the builders installed three dependable Wickes water tube steam generators. In addition to supplying the big nine-story Health Center with heat, the Wickes boilers also serve the entire City Hall building nearby, and the new Police Facilities building (a feature of this integrated Civic Center layout is that these buildings are connected to the Health Center by pedestrian tunnels, which are likewise heated by the Wickes boiler installation). Pictured at right is one of the modern health laboratories.

WICKES

STEAM GENERATORS WHERE DEPENDABILITY MOST VITAL FACTOR

The three Wickes boilers shown below supply heat for not only the Health Center but also the City Hall and new Police building.

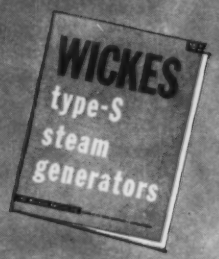


These 2-drum type-S Wickes steam generators are compact and efficient water tube units. Built to a design pressure of 160 psi, and with 3400 square feet of heating surface, each of these Wickes units is fired by 2 Multijet Combination gas and oil burners. They are quickly responsive to extreme fluctuations in load, and the large steam drums make certain of ample steaming capacity with dry steam. Wickes 2-drum type-S steam generators are readily adaptable to completely automatic control.

Other Wickes 2-drum, type-S, shop-assembled steam generators are available in the Series S1A and S2A. These units combine the water cooled furnace as an integral part of the boiler, adapting the high and low type furnace to the desired method of firing . . . coal, oil or gas. They are built to the design pressure of 725 psi; superheaters and recovery equipment are available.

WRITE FOR OUR NEW BROCHURE

Our new Catalog 55-2 contains complete information on Wickes 2-drum type-S steam generators. A general description is given of these shop assembled boilers, together with four insert pages of engineering drawings and data. We will also send you our complete Facilities Bulletin No. 55-1.



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THE WICKES BOILER CO.

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RECOGNIZED QUALITY SINCE 1854 • *SALES OFFICES:* • Albuquerque, N. M. • Boston • Buffalo • Charlotte, N. C. • Chicago • Cleveland • Dallas • Denver • Detroit • Fort Wayne, Ind. • Houston • Indianapolis • Los Angeles • Memphis • Milwaukee • New York City • Portland, Ore. • Saginaw • Salt Lake City • San Francisco • Springfield, Ill. • Tulsa • Washington, D. C.

NEW SUPERCHARGED

developed by Foster Wheeler

offers FIVE IMPORTANT

FOSTER WHEELER has developed a new supercharged boiler of far-reaching significance to the power industry.

In the supercharged cycle, diagrammed schematically on the facing page, high pressure combustion gases leaving the boiler are used to drive a gas turbine which, in turn, compresses combustion air for the boiler and drives an auxiliary generator. Spent gases from the turbine pass through an economizer and thence to the stack.

The following advantages are inherent in this supercharged boiler cycle.

1. There is a marked increase in overall plant economy. When utilizing maximum gas turbine operating temperatures, net power developed by the gas turbine can run as high as 15% of total plant output, with an overall gain of 10% in cycle economy. Even when operating at lower exit-gas temperatures, where the gas turbine is used only to drive the compressor, cycle economy is increased by the amount of power that would otherwise be required for operating the fans of a conventional boiler.

2. The supercharged boiler permits a rather astounding reduction in size and weight, due to much higher heat absorption rates. A supercharged boiler may weigh from ½ to ¼ as much as a conventional boiler of equivalent capacity. This, of course, permits a substantial saving in first cost—as much as 25% or more, depending on cycle conditions.

3. Start-up time is extremely short compared to that of a conventional steam generator.

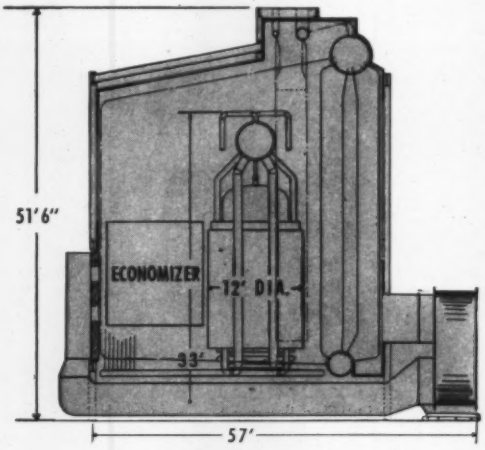
4. The supercharged boiler responds much more quickly to load changes.

5. Boilers can be completely shop fabricated and shipped ready to install.

To obtain the design symmetry essential for this pressurized firing service, the boiler drum is mounted separately above the boiler furnace—connected to it by external risers and downcomers. The furnace is fully enclosed with waterwall surface and a metal baffle separates the furnace tubes from the convection section. Superheated pancake coils are located in the base of the firing chamber.

Foster Wheeler has built three of these supercharged boilers and a fourth is now under construction. At present, units can be furnished for natural gas or light fuel firing.

For complete information on this important Foster Wheeler development, send for a copy of the December issue of "Heat Engineering". *Foster Wheeler Corporation, 165 Broadway, New York 6, N.Y.*



Comparison of physical dimensions of a conventional boiler (gray) and supercharged boiler (red). Both units are designed to furnish steam at 1200 psi, 950F for a 43,000 kw station.

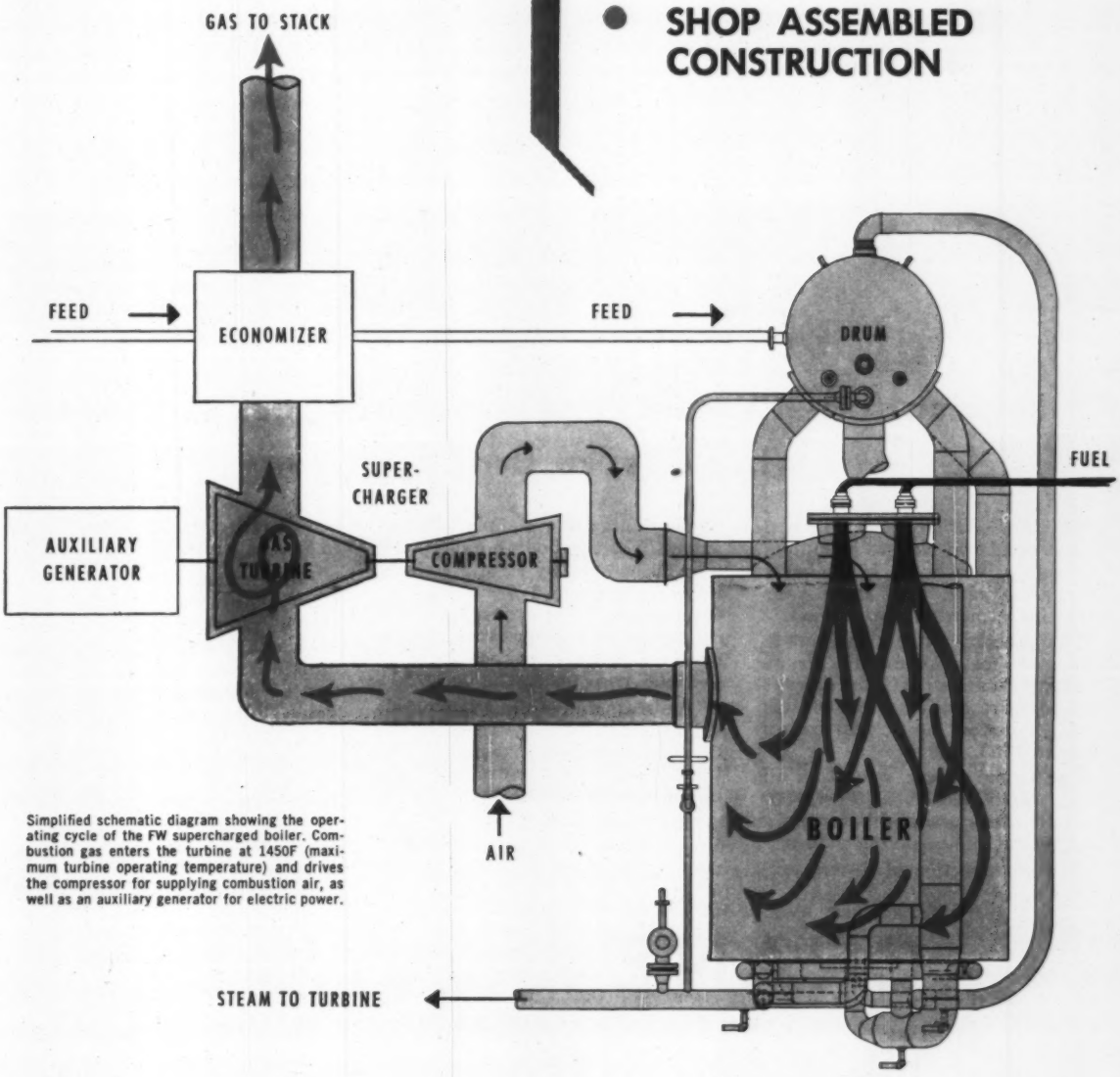
FOSTER WHEELER

NEW YORK • LONDON • PARIS • ST. CATHARINES, ONT.

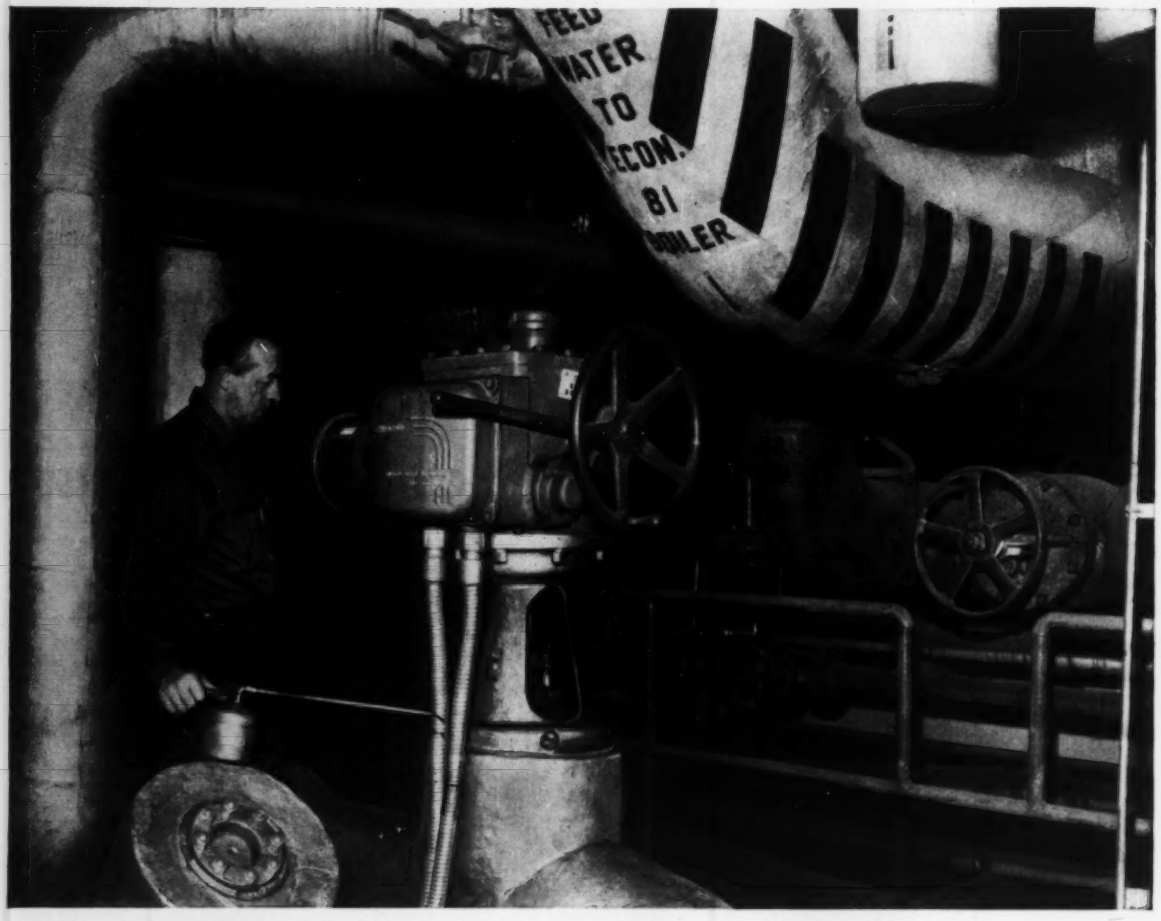
BOILER

ADVANTAGES . . .

- HIGH OVERALL ECONOMY
- DRASTIC REDUCTION IN SIZE AND WEIGHT
- SHORT STARTING TIME
- QUICK LOAD RESPONSE
- SHOP ASSEMBLED CONSTRUCTION



Simplified schematic diagram showing the operating cycle of the FW supercharged boiler. Combustion gas enters the turbine at 1450F (maximum turbine operating temperature) and drives the compressor for supplying combustion air, as well as an auxiliary generator for electric power.



Lubrication—the only maintenance cost of these high-pressure Crane valves

THE CASE HISTORY—When an oil can is all you need to keep high pressure valves at peak efficiency year after year, you know your valve investment is a wise one.

That's how Philadelphia Electric Company feels about the Crane Pressure-Seal Bonnet Gate Valves at its Delaware Station—one of this utility's newest units, started up early in 1953.

The Crane valves, operating on boiler feed service at 2000 psi, 500° F., have demonstrated completely their maintenance-saving values.

The old practice of re-stressing bonnet bolts doesn't apply to these valves. Yet the body-bonnet joint remains completely tight. Never a leak; never a need for a wrench. Crane Pressure-Seal design, utilizing internal fluid pressure, maintains a positively leakproof metal-to-metal joint inside the body.

The seats and stuffing box on all valves remain equally tight. Operation is smooth, nonsticking. The Crane flexible wedge disc prevents binding under contraction.

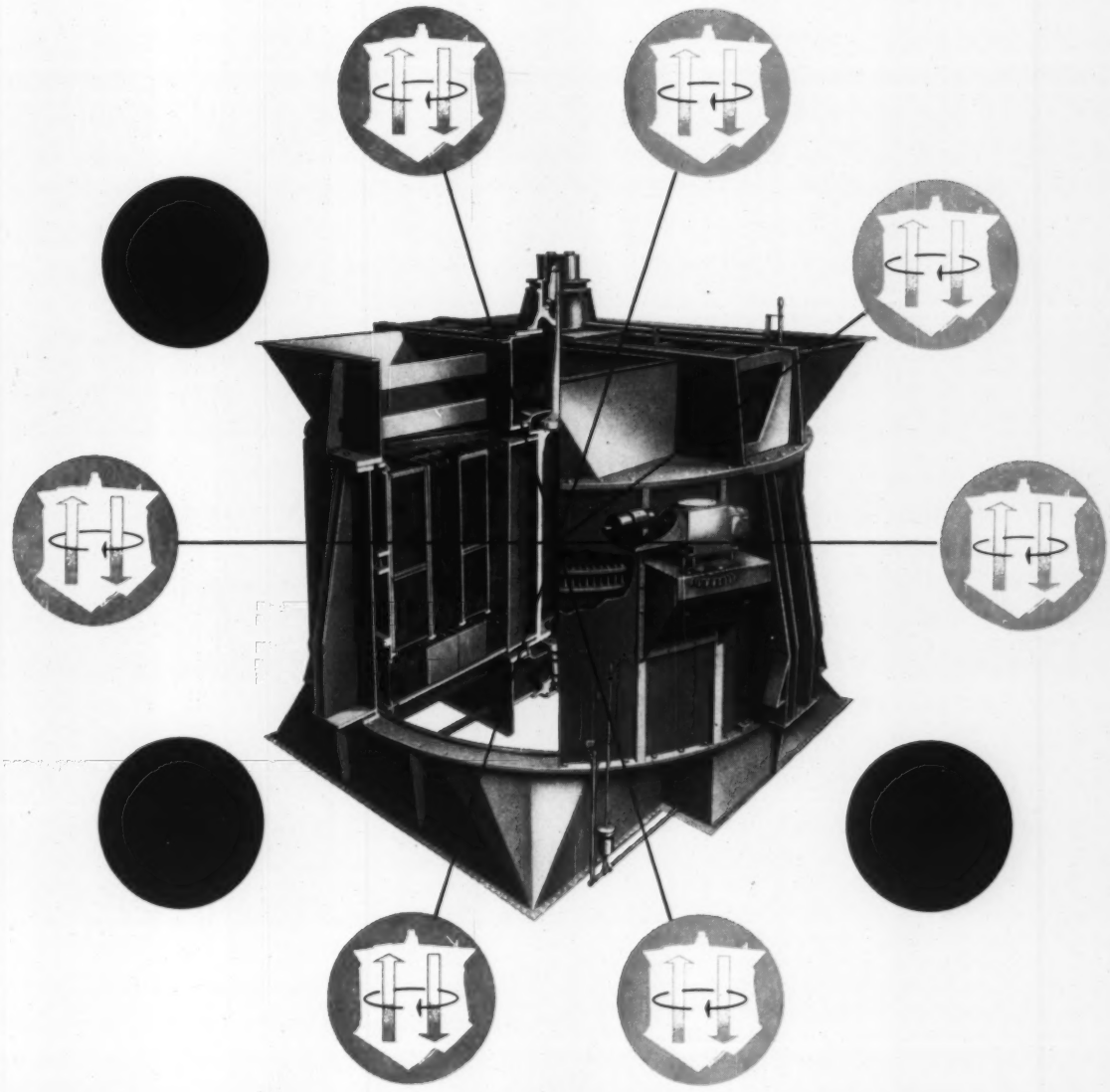
Other value features of Crane Pressure-Seal design are compactness . . . weight saving with no loss of strength . . . and clean exterior lines that simplify insulation.

Power plants around the world report new performance records for Crane Pressure-Seal Bonnet Valves. Now's the time to consider this advanced design—in gates, globes, angles and stop-checks—for modernization or extension projects. Contact your local Crane Representative or write to address below.

CRANE VALVES & FITTINGS

PIPE • KITCHENS • PLUMBING • HEATING

Since 1855—Crane Co., General Offices: Chicago 5, Ill. Branches and Wholesalers Serving All Areas



7 out of 10 *air preheater installations are Ljungstrom®*

Advantages of the Ljungstrom Air Preheater

- Size for size, recovers more heat than any other type.
- Reduces fuel consumption. Permits use of lower-grade fuels. Increases boiler output and reliability.
- Eliminates cold spots . . . keeps corrosion to a minimum.
- Easier, faster to clean and maintain.
- Requires far less supporting steel and is quickly erected.

FUEL ECONOMY is the big reason. Size for size, the Ljungstrom recovers more heat than any other type of air preheater. And with every 45-50 F of air preheat you cut your fuel bill 1%.

Write now for your copy of our 38-page manual, for handy reference.

The Air Preheater Corporation 60 East 42nd Street, New York 17, N. Y.

Cylindrical Roller Bearing Inner Races

Their vital importance in bearing performance . . . advantages of carburizing . . . the manufacturing procedures which assure maximum quality and life

The function of an inner race is to provide a fatigue-resistant surface between a shaft and the rollers of an anti-friction bearing. Because of the geometry of a roller bearing, there is a smaller area of contact between the inner race and rollers than there is between the outer race and rollers.

This smaller area of contact has the effect of concentrating the loads on the inner race to a greater degree. Therefore, the inner race is always the critical member of a roller bearing from a fatigue life standpoint. When the inner race is the stationary member and the outer race rotates, this load concentration on the inner race is even more of a factor since the maximum load is repeatedly applied at one point.

Adequate resistance to relative movement between the inner race and shaft is vital to satisfactory performance. HYATT inner races are made of materials chosen to permit relatively heavy press fits. When HYATT press fitting recommendations are followed, the inner race becomes an integral part of the shaft for all practical purposes.

1. WHY CARBURIZING?

HYATT inner races are made of a good *carburizing* grade of steel, rather than through-hardened steel, for several reasons. First, carburizing permits the vital heavy press fits referred to above. Second, tough flanges that will not break out under impact can be obtained on carburized races with no loss of case hardness. Third, carburizing improves load-carrying capacity, as shown in Diagram A. During quenching, the phase change from austenite to martensite which occurs in the outer case is accompanied by a volumetric change; but the low carbon core remains tough and ductile *without* appreciable volumetric change. The result is a tendency to stretch the core and compress the case. Due to the Poisson effect, *the compressive hoop stresses in the external fibres build up the load-carrying capacity of the race.*

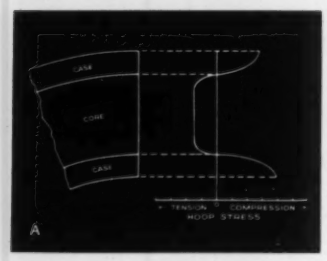
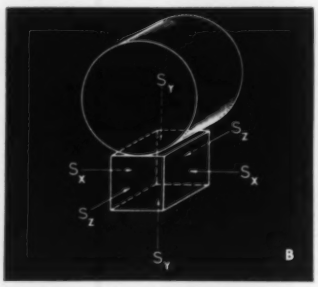


Diagram B shows a typical element of a HYATT carburized inner race under roller load. Stresses in the "Z" direction are negligible. Stresses in the "X" direction are compressive hoop stresses or preload. Stresses in the "Y" direction are compressive stresses due to the load. Without the compressive stress Sx (hoop stress) the load-carrying capacity would be less; and should the stress in the "X" direction become a tensile stress due to pressing a through-hardened race on a solid shaft, the capacity would be still further reduced. Reference to applicable theories of material failure will support this view and indicate why HYATT has gone to substantial added expense to give customers the benefits of carburized inner races.



2. OPERATIONAL REQUIREMENTS

A top-quality inner race should have all the following characteristics:

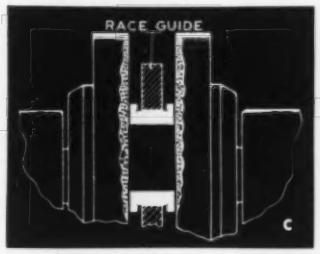
1. *Minimum wall variation:* Concentricity of the inner race pathway to bore is necessary for quiet operation at full bearing capacity.
2. *Minimum runout of race ends to bore:* The bearing must not be cocked on the shaft by location against a square shoulder with a race end having excessive runout.
3. *Minimum runout of race flange inner faces to bore:* Excessive flange face runout results in noisy operation and hunting of the shaft.
4. *Minimum bore tolerance:* An important fitting consideration. If all the available tolerance is taken in the race bore, the shaft tolerance is unnecessarily restrictive.
5. *Minimum pathway and bore taper:* Taper causes uneven roller loading with resultant overheating and poor life.

3. MANUFACTURING PROCEDURES

Good control of primary machining is reflected in good quality of the finished product. The early stages of manufacture, through the heat treating operation, are highly important and are all scrupulously controlled by HYATT. In this article, however, the *finishing operations* are of primary interest and will be discussed in detail.

Centerless grinding operation on a large Hyatt inner race.

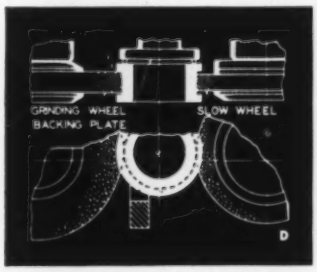
4. DOUBLE END GRIND



The sequence of grinding operations is important. The ends must first be faced off *square and parallel* so that during subsequent operations the ends can be used as accurate reference. The HYATT double end grind operation illustrated in Diagram C insures excellent control of race end parallelism.

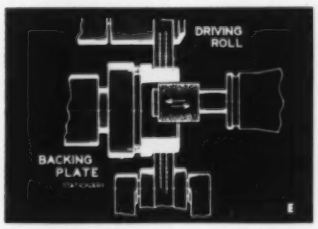
5. CENTERLESS PATHWAY GRIND

The centerless grinding principle was pioneered by HYATT many years ago. This method was a significant improvement over existing chucking methods because it eliminates excessive wall variation introduced by spindle and chucking errors.



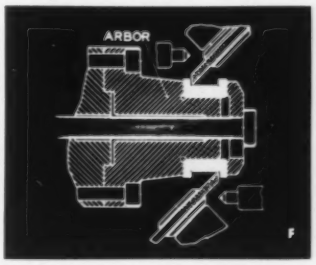
The race pathway is ground by the centerless method to produce a race with as nearly a perfectly round diameter as is commercially practical. Two-point and three-point out of round as well as taper are held to a minimum. Note that the work is rotated with a backing plate against the previously ground end, as shown in Diagram D.

6. CHUCKLESS BORE GRIND



Here again the centerless method is employed to generate an inner diameter (bore) concentric with the outer diameter (pathway.) This is accomplished by driving the race on the outer diameter and positioning the grinding wheel relative to the drive roll. The result is maintenance of minimum wall variation by removing stock from the high spots as they pass between the drive roll and the grinding wheel, as shown in Diagram E.

7. FLANGE GRINDING



All flange faces must be ground to run true with the roller pathway. Since the pathway and bore have been ground using the ends as a reference, the ends are also used as reference while grinding the flange faces (Diagram F). This establishes all-important even contact with the roller ends during operation of the bearing.

8. VIGILANT INSPECTION

Strict inspection is vital to the maintenance of high-quality standards in a precision product such as roller bearings. Working with the finest test equipment under conscientious supervision, highly trained HYATT inspection teams constantly watch the quality of HYATT parts as they are produced. This insures traditional HYATT dependability.

YOU WILL FIND FURTHER DETAILS

in HYATT General Catalog No. 150, or your nearby HYATT Sales Engineer will gladly help you choose the type of cylindrical roller bearings best suited to your design requirements. Remember, HYATT is America's *first* and *foremost* maker of roller bearings. Hyatt Bearings Division of General Motors Corporation, Harrison, New Jersey.

GM GENERAL MOTORS

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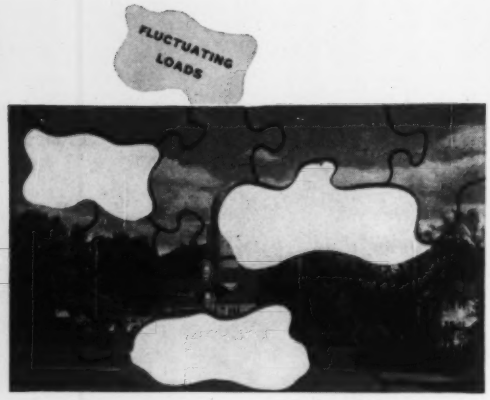
ROLLER BEARINGS



HOW A JIGSAW HEATING PUZZLE WAS SOLVED

KEWANEE reserve plus rated boilers

MET SCHOOL HEATING NEEDS

A jigsaw puzzle heating problem . . . that's what it looked like at the Cranbrook School for Boys, Bloomfield Hills, Michigan, since the heating needs were so varied. But every puzzle piece fell into place when Kewanee Reserve Plus Rated Boilers were installed, because all heating needs were solved. Here's the way it worked:

Problem 1: Limited boiler room.

Solution: Two compact Kewanee Scotch Type Boilers with 50% reserve power guaranteed adequate heat under all conditions.

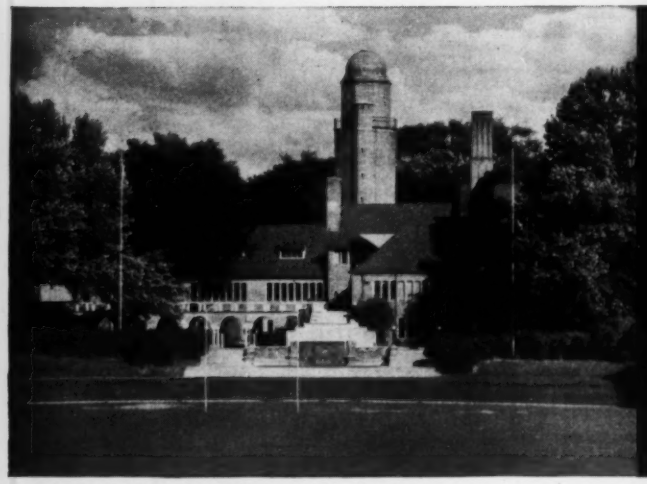
Problem 2: Fluctuating loads—boiler turned off nightly, turned on by stages in the morning.

Solution: Kewanee Boilers had sufficient reserve to assure a fast, dry steam when needed to give quick heat.

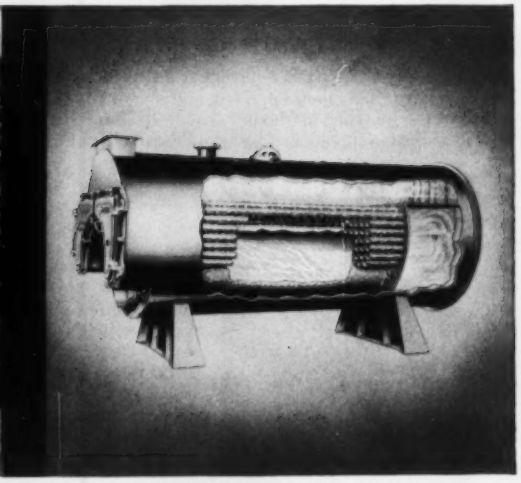
Problem 3: Low operating—maintenance costs.

Solution: Since Kewanee Reserve Plus Rated Boilers certify 50% extra power built in, they operate at "cruising speed." Result—less fuel used, less wear on boiler, greater efficiency delivered.

Kewanee Reserve Plus means boilers are rated on nominal capacity, with adequate power to take care of present needs, emergencies and future expansion. Boilers rated on maximum capacity are inadequate for today's fast growing school needs. Next time select Kewanee Boilers.



Cranbrook School for Boys, Bloomfield Hills, Michigan
Heating Contractor: Laing Plumbing & Heating Company, Pontiac, Michigan
Engineer: Snyder & McLean, Detroit, Michigan



Kewanee LM-800 Series for 15 lbs. steam or 30 lbs. water installed in the Cranbrook School for Boys.

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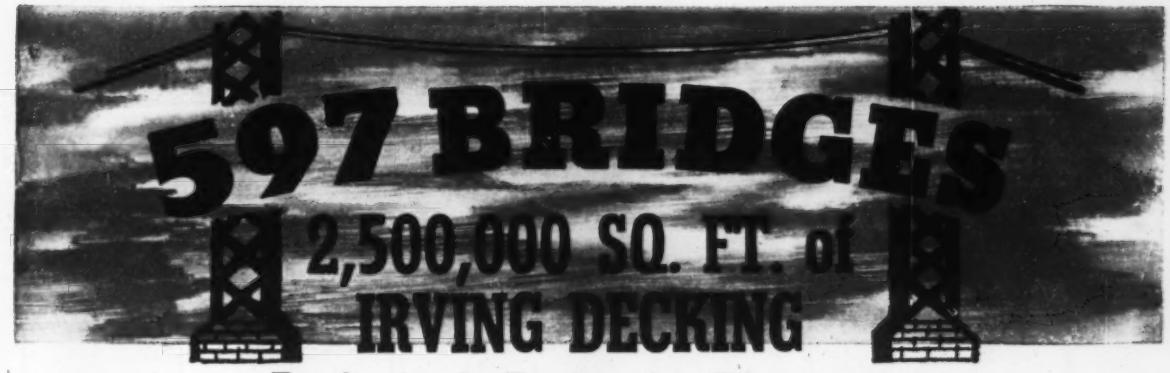
101 FRANKLIN STREET, KEWANEE, ILLINOIS

KEWANEE BOILERS

You can depend on Kewanee engineering



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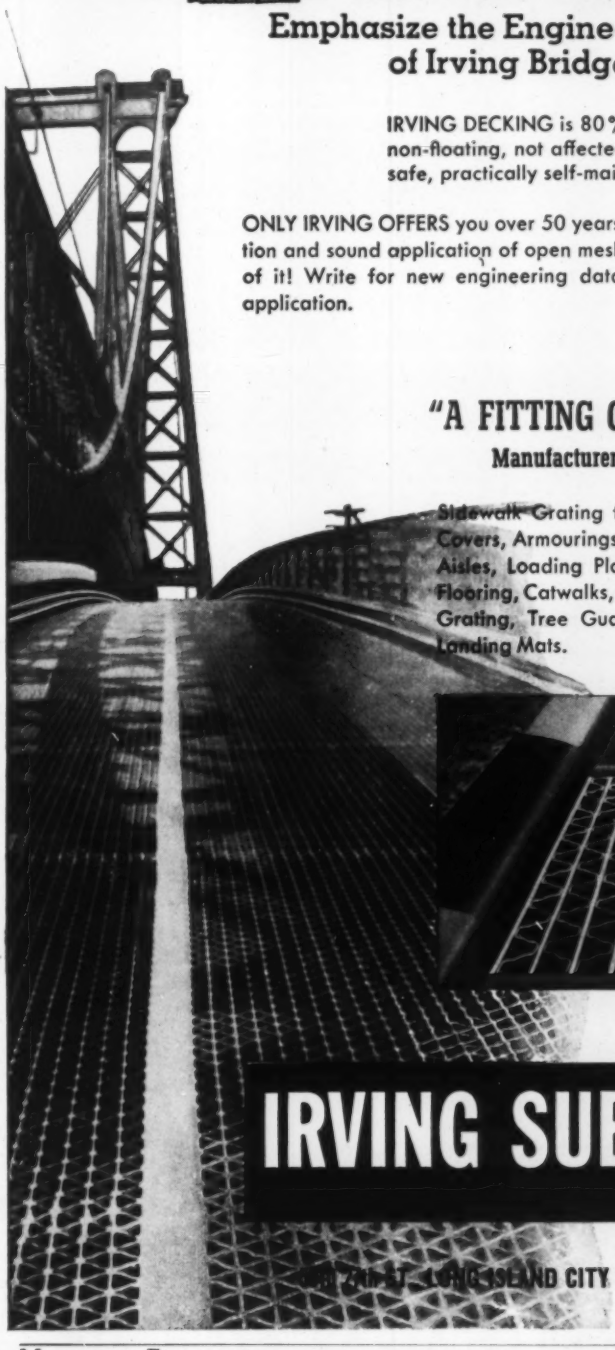

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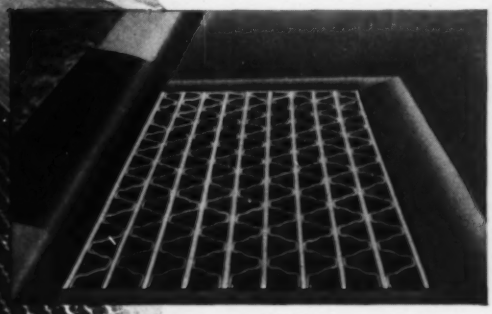

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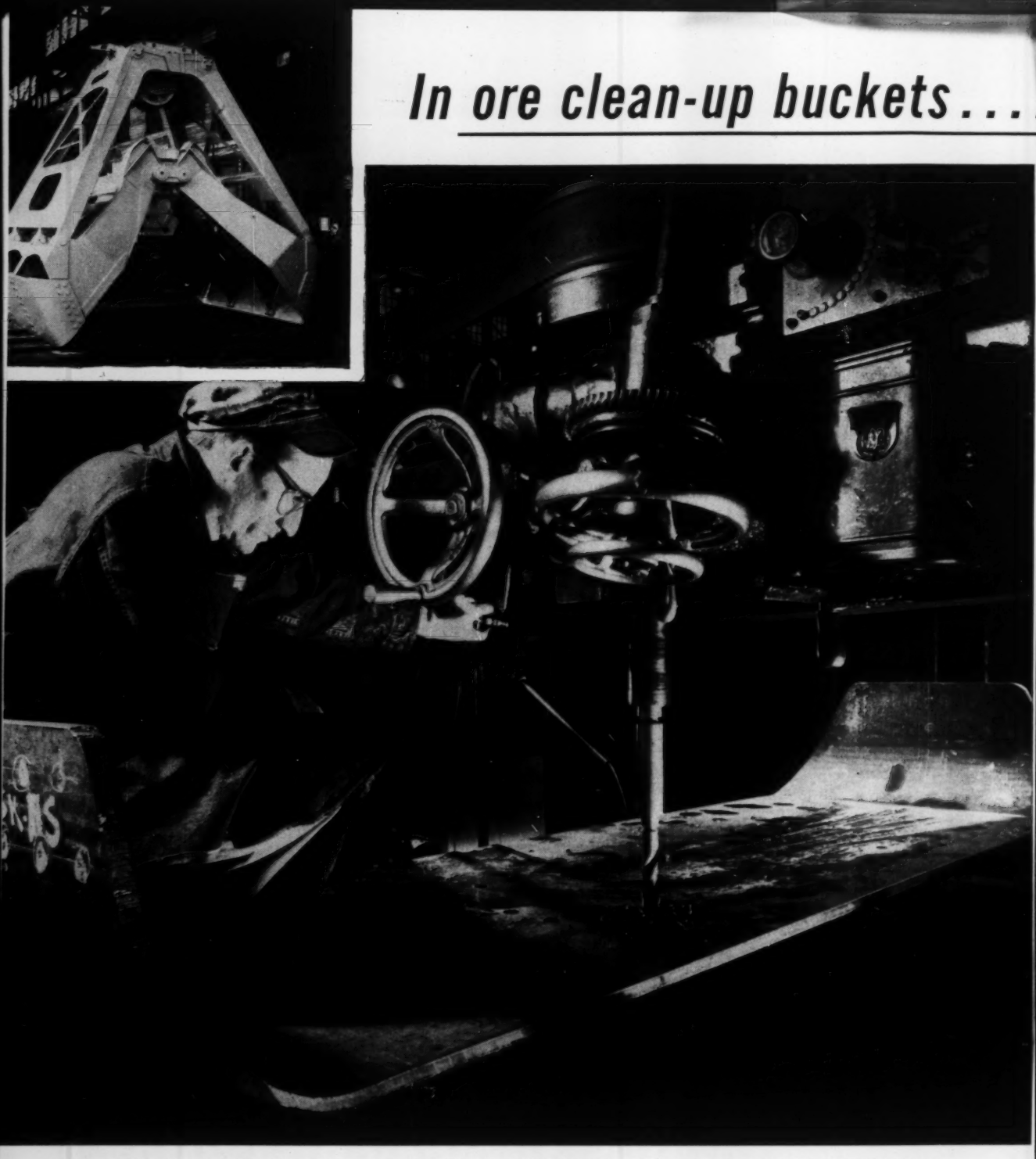
In ore clean-up buckets . . .



HALF AS THICK! In the trays for giant ore clean-up buckets, 1¼" USS "T-1" Steel Plate, with a yield strength of 90,000 psi., replaces cast trays which were as much as 2½" thick. The new buckets—lighter in weight by more than half a ton—and expected to outperform the heavy cast trays, will be used at United States Steel's South Works.

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UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS "T-1" CONSTRUCTIONAL ALLOY STEEL USS

FABRICATION SIMPLIFIED WITH USS "T-1" STEEL

(plus weight reduction of more than ½ ton)

The trays of ore clean-up buckets must have phenomenal shock and abrasion resistance to hold up under constant scraping and scouring along the steel bottoms of ore boats. They are commonly made of heavy steel castings. But recently, Blaw-Knox Company, Pittsburgh, Pa., *fabricated* trays for several new buckets from USS "T-1" Steel Plate. This amazing new alloy steel assures the needed strength and durability, plus important fabricating advantages.

LESS WEIGHT—LESS EXPENSE

Biggest single advantage of fabricating from USS "T-1" Steel Plate is less weight. New trays weigh only 4,021 pounds each, compared to 5,068 pounds for comparable cast manganese steel trays. Thus, USS "T-1" Steel decreases the weight of the bucket and reduces shipping and handling costs.

What's more, fabrication from USS "T-1" Steel simplified the building of these huge buckets. It eliminated the expensive patterns needed for cast trays. Because USS "T-1" Steel has tremendous resistance to impact abuse and abrasion, it is expected that it will outperform previously used materials.

For these ore buckets, USS "T-1" Steel is flame-cut to size, *cold formed* in a 1,250-ton press, drilled and then riveted to the bucket shell. USS "T-1" also can be welded—without pre- or post-heating. Because of its unusual combination of properties, it is cutting costs in many rugged applications.

LOOK AROUND YOUR SHOP

In your own equipment, or in the products you make for others—wherever you would like to increase service life . . . wherever you would like to reduce fabricating costs of heavy-duty parts—look into the possibility of using USS "T-1" Steel. Competent technical advice is always available, of course — free of charge — from United States Steel. Write, wire, or phone for complete information. United States Steel, Room 5206, Pittsburgh 30, Pa.

See "THE UNITED STATES STEEL HOUR"—Televised alternate weeks—Consult your newspaper for time and station.

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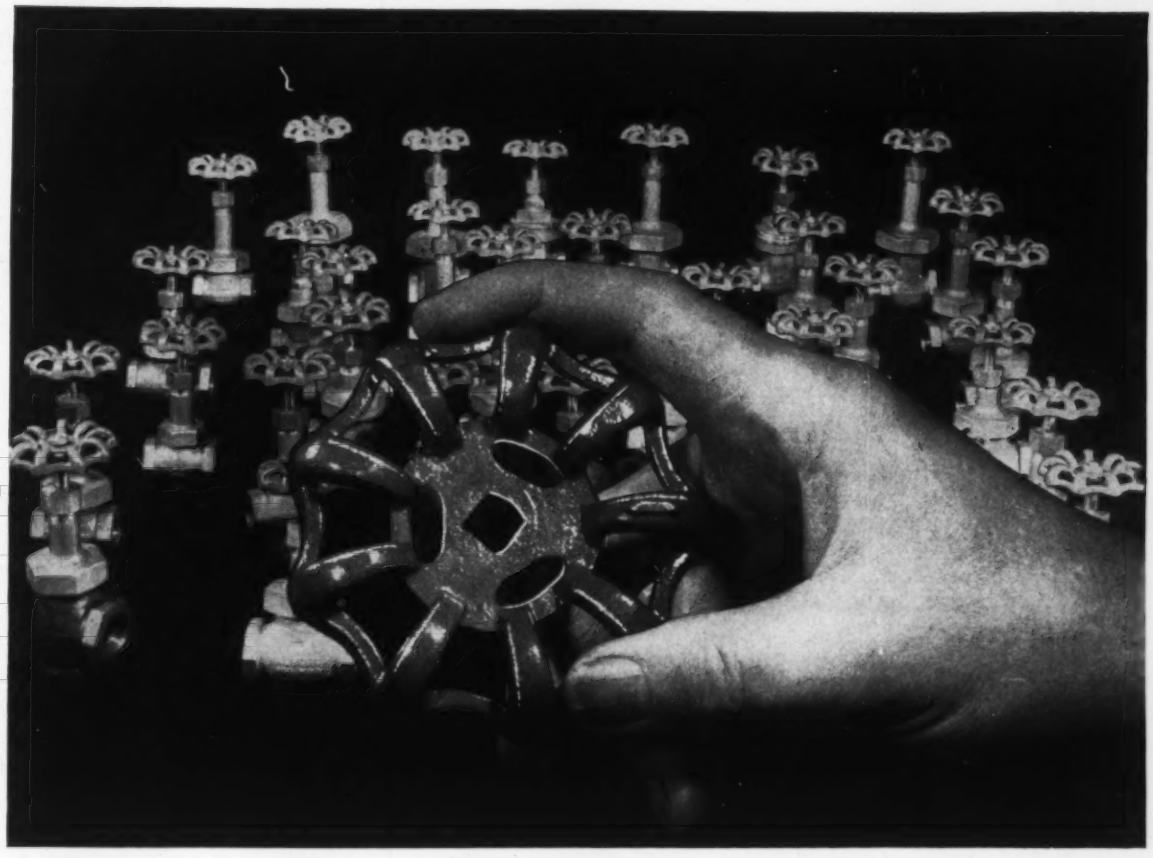
This picture of southwestern U. S. and Mexico is an official United States Navy photograph made from the research rocket, Viking 12, at an altitude of 143.4 miles.



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*Walworth Handwheel No. 16 fits these Walworth Bronze Valves:	
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1¼"	No. 58, 59
1½"	No. 2, 3, 4, 11, 12, 14

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Improves appearance **Won't tear vapor barrier**

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1. Mechanic depresses insulation exposing tip of pin.

2. Pin is engaged by locking-holes on clip.

3. Clip is pushed home flush with insulation surface.

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Johns-Manville's Industrial Contract Department has worked closely with the Graham Manufacturing Corporation in field-testing the Graham *Flush Clip* on industrial installations. Used in conjunction with the Graham Insul-Pin System, it has been proven to operate ideally with J-M Spintex Insulation, plain and faced. For more information and samples, contact your nearest J-M Insulation Contractor. Or write Johns-Manville, Box 60, New York 16, New York. In Canada, Port Credit, Ontario.

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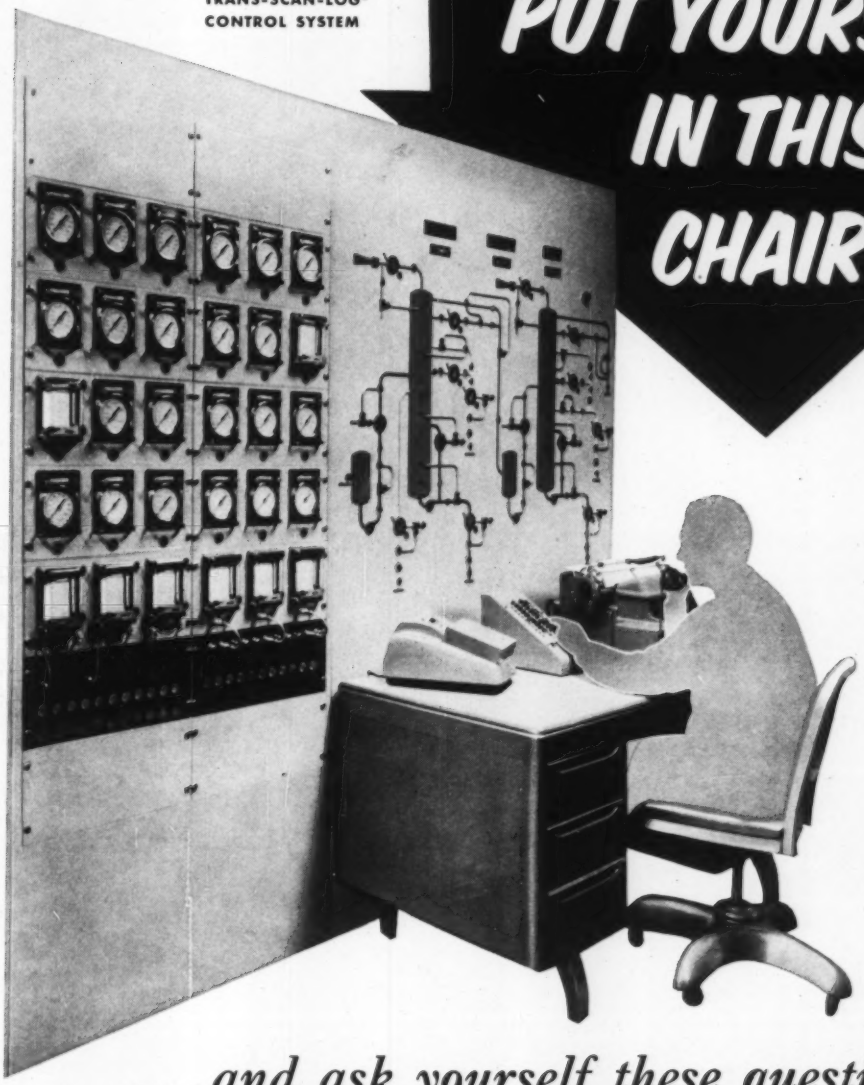

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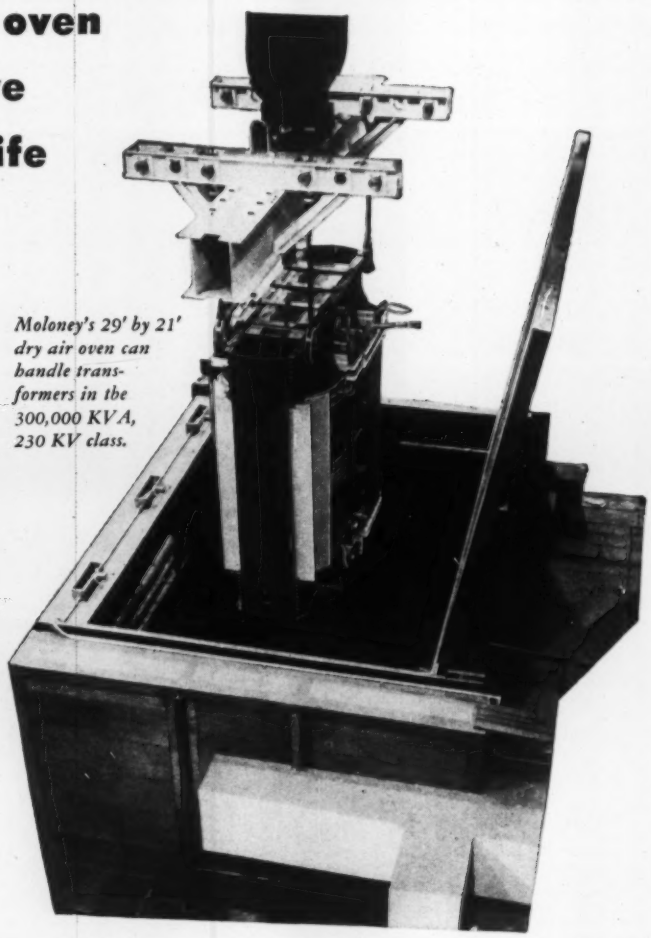
Moloney power transformers are dried in new controlled atmosphere oven to further improve performance and life

A Type CH Lectrodryer like this does the DRYing.



Moloney's 29' by 21' dry air oven can handle transformers in the 300,000 KVA, 230 KV class.

Air fed to oven by Lectrodryer* contains only 1/10th grain of water per cubic foot

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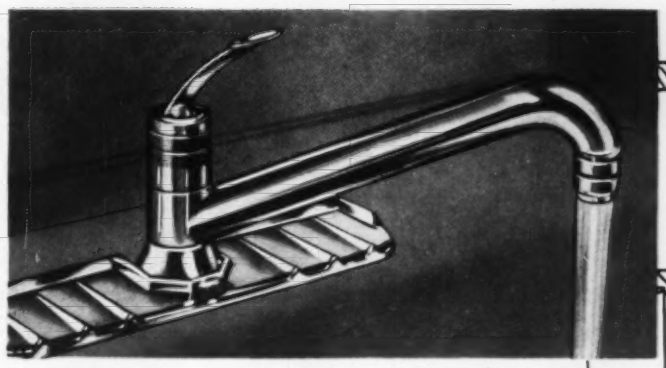
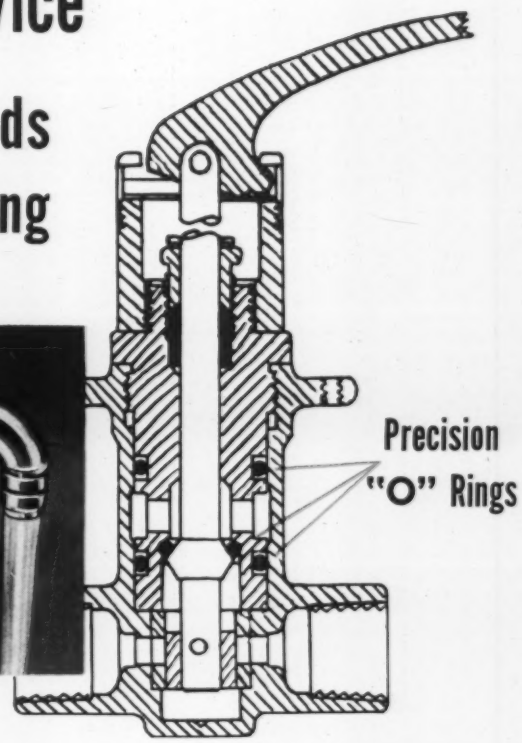


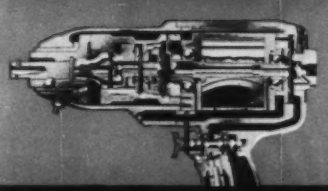


The Gyro Brass Manufacturing Corporation water faucet has no washers, spindles or seats to replace or renew. With the aid of Precision "O" Rings, a single motion controls both water volume and temperature. Dripping is eliminated. Endurance tests indicate ring life of over 15 years of normal service.

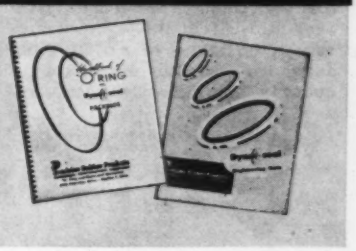
For Gyro Brass Manufacturing Corporation, and for hundreds of other manufacturers, the use of Precision "O" Rings means dependable long life service. They are compression molded—rigidly inspected—meet all military and commercial specifications—the finest made! At Precision, you'll find "O" rings in sizes and compounds to meet your requirements.

What is your sealing problem? There is an expert—the Precision engineer—ready to help you in product design and "O" ring specifications. You can rely on him—and on Precision, the world's largest exclusive producer of "O" Rings.

Job fitted Precision "O" Rings have solved hundreds of industrial, aircraft and automotive sealing problems.



In air-powered impact wrench, 14 floating "O" rings help achieve compactness, result in reduced break-out friction and lower running friction.



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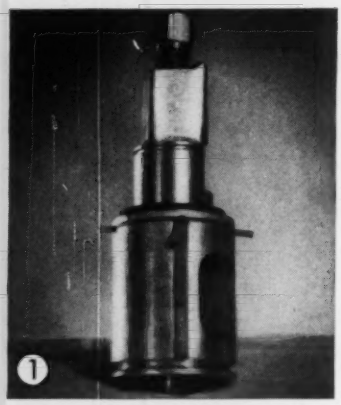
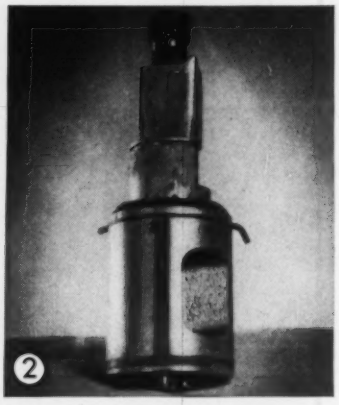
PRESSURIZED LUBRICATION
GUARANTEES LOWEST COST SERVICE FROM

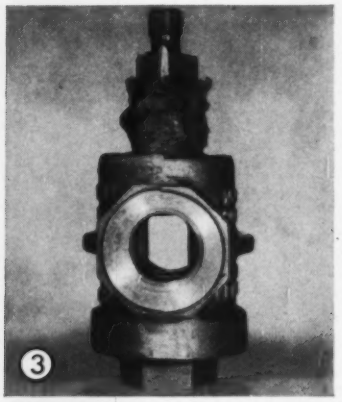
HOMESTEAD *lubricated* PLUG VALVES



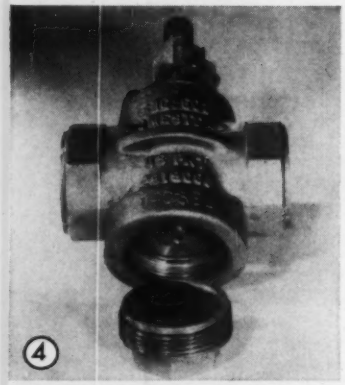
This plug was removed from a Homestead Valve just after starting lubrication, and before all sealing areas were filled with lubricant. Note that pressurized lubricant continues to extrude through feeder holes. Momentary downward movement of plug at start of each lubrication, gives assurance that plug is always free to turn.



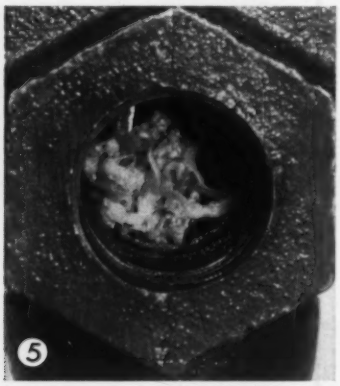
The plug was again withdrawn from the valve body just after a ring of lubricant around the stem indicated that the lubricant system was full. Note that all lubricant grooves are filled. The entire plug surface is coated with lubricant. Lubricant is well packed in the stem sealing area above the plug.



Now valve has been purposely over-lubricated as indicated by excess lubricant around stem. Note that with *controlled* pressurized lubrication there is no extrusion or seepage of lubricant into valve port opening. This means no waste, no contamination of line fluids, no clogging of low pressure lines with lubricant, or fouling of meters, orifices, etc.



Also, in the Homestead Valve with *controlled* lubrication, you will note that even though the valve has been over-lubricated, lubricant comes only to the bottom edge of the plug, and is not wasted by discharging in quantity into the bottom chamber.



Now, see for yourself the risk involved when a valve which does *not* have Homestead's *controlled* Pressurized Lubrication, is over-lubricated. Note lubricant has been forced into the port opening. It can contaminate line fluids, foul meters or orifices, or even block low pressure lines!

* Unretouched photos.

These are but a few of the many advantages of Homestead's controlled pressurized lubrication that guarantee lowest cost valve service.

Reference Book 39-5 has the full story—twenty-eight pages of engineering facts, sizes, types, dimensions, etc. Ask for your copy today. There is no obligation.

HOMESTEAD LUBRICATED PLUG VALVE (Pat. Pend.)

HOMESTEAD VALVE MANUFACTURING COMPANY

P. O. Box 38 *"Serving Since 1892"* Coraopolis, Pa.

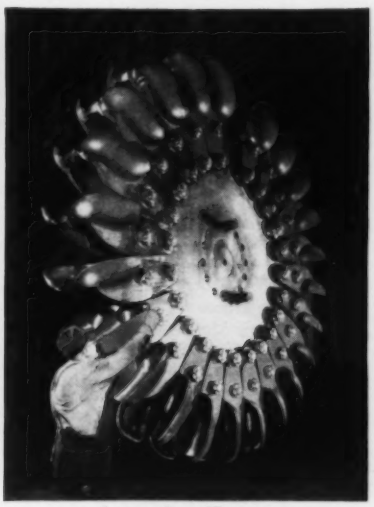
3 TYPES of Hydraulic Turbines

Propeller Type

Regularly chosen for low heads, up to 100 feet normally, and in exceptional cases even higher. Its higher speed effects appreciable savings in generator cost.

Francis Type

Used for heads up to 1000 feet — in some cases even higher heads — depending on the output capacity of the unit, the quality of operating water, and the character of load to be carried.



Impulse Type

For heads as high as pressure pipe lines can be built. Used for heads as low as 200 feet if water conditions prevent use of Francis type because of excessive wear.

Hydraulic TURBINES

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ALLIS-CHALMERS WILL WORK WITH YOU and your consulting engineers to help decide. You'll take advantage of over 50 years' experience designing and building hydraulic turbines.

Besides building all three principal types of hydraulic turbines — Francis, propeller and impulse — Allis-Chalmers is in a unique position. It is the only company which can provide, in addition to the turbine, nearly all the other electrical equipment and auxiliaries needed. Generators, transformers, switchgear lead the list. The company can also provide pressure regulators, valves and governors for large units.

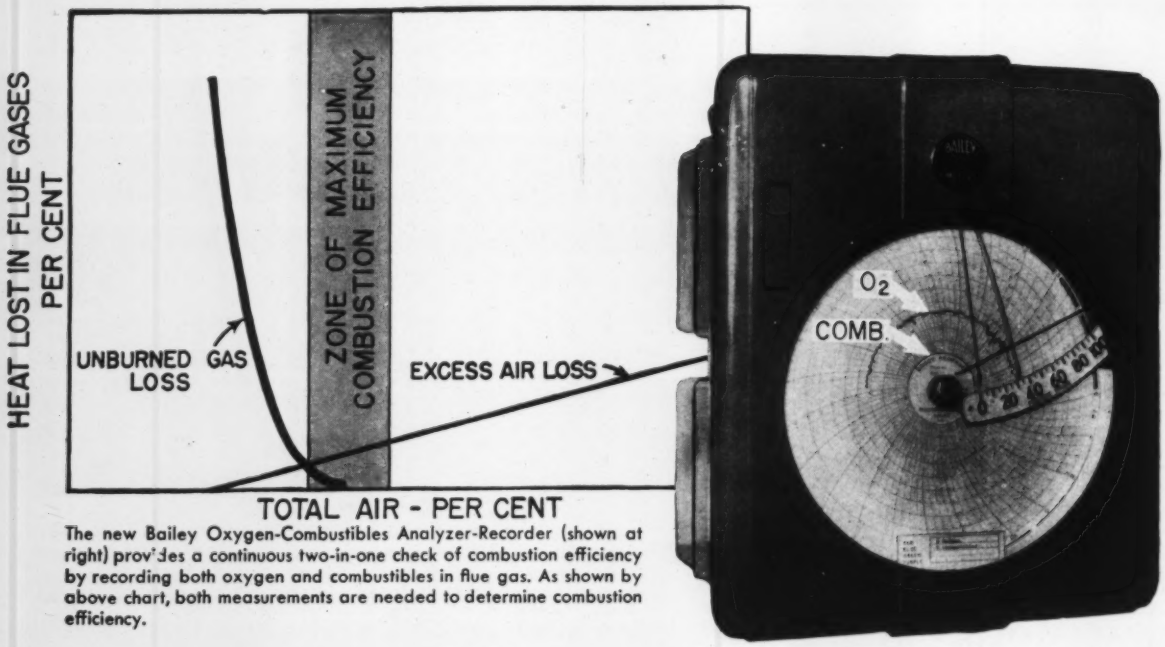
In many instances substantial savings can be realized by calling in Allis-Chalmers engineers to discuss the problem even before definite planning is begun. For all or any part of your needs, it will pay to contact the Allis-Chalmers representative nearest you. Or write Allis-Chalmers, Milwaukee 1, Wisconsin, U. S. A.

A-4586

ALLIS-CHALMERS

Manufacturing Plants in United States and Canada

Over 14½ million installed horsepower of hydraulic turbines throughout the world.



The new Bailey Oxygen-Combustibles Analyzer-Recorder (shown at right) provides a continuous two-in-one check of combustion efficiency by recording both oxygen and combustibles in flue gas. As shown by above chart, both measurements are needed to determine combustion efficiency.

BAILEY announces • • •
New 2 in 1 way to measure Combustion Efficiency

The new Bailey Oxygen-Combustibles Analyzer-Recorder gives you a continuing double check on combustion economy. It's fast response measures and records:

1. Excess air—regardless of the fuel or combinations of fuels being burned.

2. The mixing efficiency of your fuel-burning equipment—by indicating the amount of combustibles in your flue gas, resulting from incomplete mixing of fuel and air.

Combustion efficiency depends upon fuel-air ratio. Too much fuel can be even more costly than too much air. And because of the interdependence of these two factors, no control that measures only one of them can give you complete protection.

Now, for the first time, you can check *both* with a *single* fast acting instrument, using the new Bailey Oxygen-Combustibles Analyzer-Recorder for industrial furnaces, kilns, heaters and boilers.

Fuel economy improves as excess air is reduced —until unburned fuel begins to show up in the flue gas. When this happens, combustion efficiency drops off sharply if there are further decreases in the air-fuel ratio. That's why combustion gases must be analyzed for *both* oxygen and combustibles to get a true indication of efficiency—and that is why Bailey coordinates both measurements on the same chart, to show when excess air may be reduced safely without danger of greater losses from unburned gases.

The Bailey Oxygen-Combustibles Analyzer is an approved combustion safeguard.

Ask your local Bailey engineer for suggestions on application. Equipment details in Product Specifications E65-1 and E12-5. P31-1

BAILEY METER COMPANY

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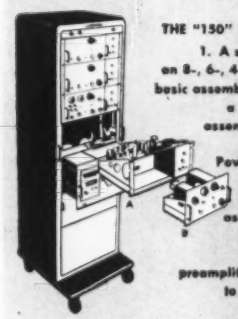
INSTRUMENTS AND CONTROLS



THE "150" DESIGN CONCEPT

1. A system starts with an 8-, 6-, 4-, 2- or 1-channel basic assembly which includes a complete recorder assembly, and a Driver Amplifier and Power Supply (A) for each channel.
2. To this basic assembly are added interchangeable plug-in type preamplifiers (B) according to the measurement requirements.

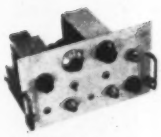
HERE'S REAL

oscillographic

RECORDING VERSATILITY

A Sanborn "150 Series" System can be set up to record any of these inputs in any of the channels

AC or DC Signals,



AC-DC Preamp

balanced or single-ended, with sensitivity of 1 mv to 2 v/cm (AC), 1 mv to 2 v/mm (DC).

Voltage Levels Recorded Logarithmically

LOG-AUDIO Preamp

Audio signals (20 cycles to 20 KC) or DC voltages recorded in logarithmic fashion on 50 decibel chart.

Higher Level Signals,

INPUT COUPLING NETWORK

where maximum sensitivity of 1 v/cm, and input impedance of about 200,000 ohms are adequate.

Magnitude and Direction of Physical Variables,

CARRIER Preamp

with variable resistance, differential transformer or variable reluctance transducers.

Extremely Low Voltages and Currents,

LOW LEVEL Preamp

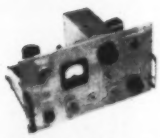
at sensitivities of 100 μv and 1 μa per cm. (with external shunt of 100 ohms), by means of DC chopper circuit.

RMS Values of AC Voltages, Currents,

VOLT/AMMETER Preamp

from 25-250 volts, 50 ma — 1 amp.

AC Voltage Components



SERVO MONITOR Preamp

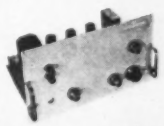
in phase or 180° out of phase with a reference voltage (e.g., servo error signal).

Low Level Signals,

STABILIZED DC Preamp

with extreme stability, high gain, and greater bandwidth than with 150-1500 Low Level Preamplifier.

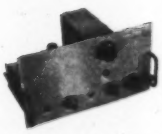
Symmetric or Asymmetric Wave Form Inputs,



FREQUENCY DEVIATION Preamp

in 350-450 cycles (2 cycles/mm) and 375-425 cycles (1 cycle/mm) ranges.

DC Signals



DC COUPLING Preamp

(push-pull, single-ended or difference between two). Basic sensitivity 50 mv/cm to 50 v/cm.

Average Value of AC Watts in a Circuit,

AC WATTMETER Preamp

in ranges from 25 volts x 40 ma to 250 volts x 2 amps. (with internal multipliers and shunts which can handle up to 4 amps).

INTRODUCED AT I.R.E. SHOW

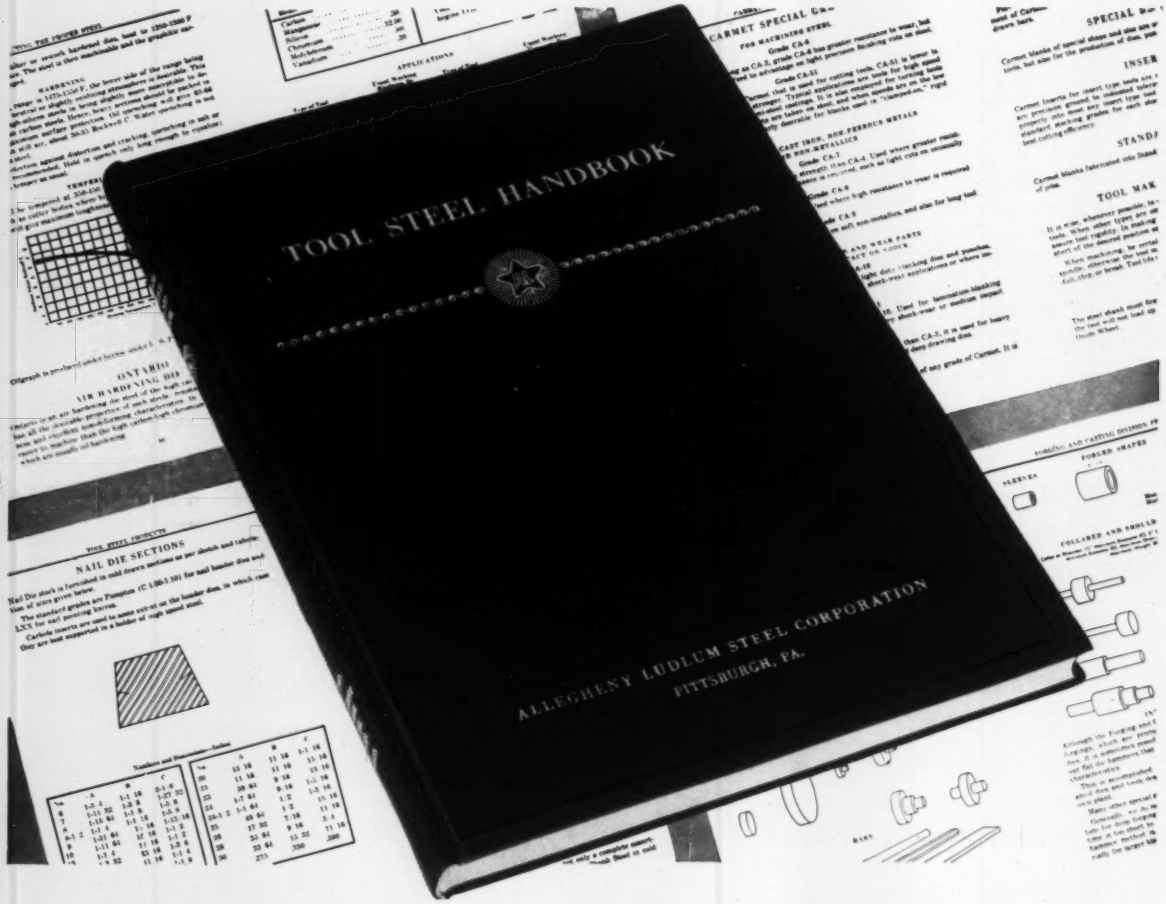
COMPLETE, SELF-CONTAINED EIGHT-CHANNEL SYSTEM ADDED TO 150 SERIES

Model 158-5490 is intended primarily for use with analog computers but capable of other types of recording. Features include 0.1v/cm sensitivity, push-pull or single-ended input, 5 meg. input impedance each input lead to ground. Frequency response is flat to 20 cps, down 2 db at 60 cps for all amplitudes to 4 cm peak to peak.

AND, in addition to this great versatility, *equally valuable* to the user are the basic design features of Sanborn oscillographic recording systems, many of them available *only* in Sanborn equipment. They include inkless recording in true rectangular co-ordinates; improved overall linearity; numerous chart speeds; a choice of vertical mobile-cabinet or portable-case packaging; availability of 2-, 4-, 6- and 8-channel systems especially designed for recording analog computer outputs.

Sanborn engineers will be glad to help you select the equipment best suited to your needs. Contact them with confidence, and ask for a copy of the new and complete "150 Series" catalog.

SANBORN COMPANY, CAMBRIDGE 39, MASSACHUSETTS



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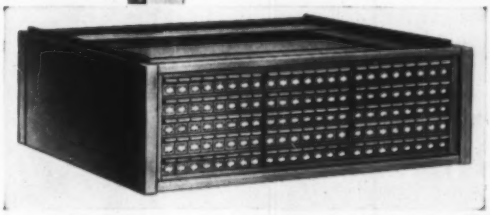

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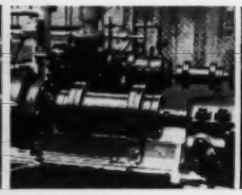
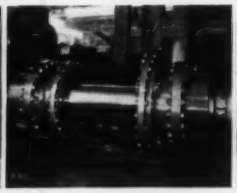
Paper Industry

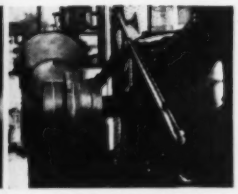


Oil and Gas Industry

Marine Industry

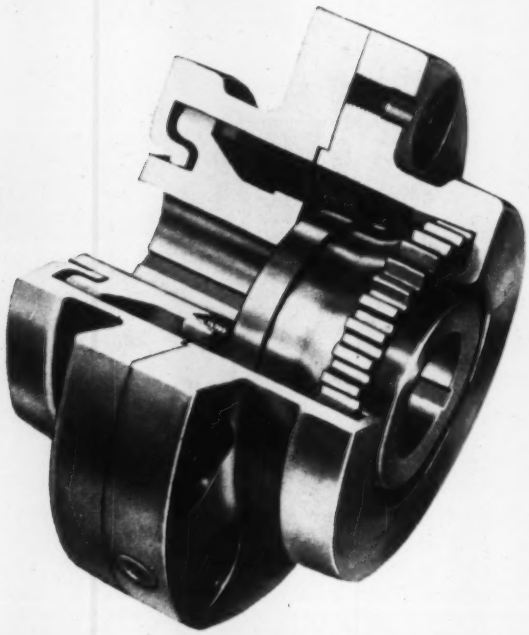


Steel Industry

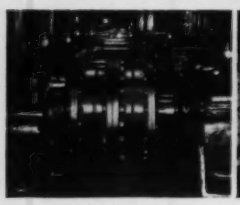


Oil and Gas Industry

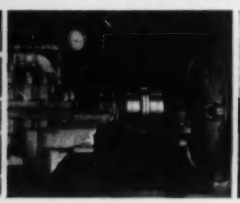
Why have Fast's Couplings always been the leader in the rugged steel industry?



Why are they used so widely to couple machinery in Power Generation, Pulp and Paper, Oil and Gas, Marine Propulsion and Auxiliaries, Steel and industry in general?

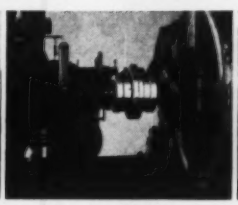


Steel Industry

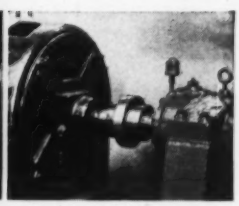


Power Industry

Lumber Industry



Chemical Industry



Paper Industry

Fast's Couplings are standard equipment with more machinery manufacturers than any shaft coupling on the American market. Many Fast's Couplings in use over 30 years still show no signs of wear when disassembled! That's the answer: they're reliable, they're *mechanically* flexible, they don't wear. They have no parts subject to repeated bending, tension or compression. There is no metal-to-metal contact, because of *positive lubrication.* Regardless of your field—no matter whether your connected machine is driven by steam turbine or electric motor, low-speed diesel or high-speed gas turbine . . . Koppers has the perfect, low-cost solution to your shaft coupling problem.

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1085 **STANDARD SIZES** of OILITE self-lubricating bronze bearings now are available to you through your local OILITE Dealer.

Now you save set-up and tooling costs on standard OILITE bronze self-lubricating bearings. From *a total of 1085* standard sizes in OILITE bronze bearing stocks—including *315* new standard sizes—you can fill nearly all of your self-lubricating bronze bearing requirements. Faster! Economically! In any quantity!

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And for help on unusual bearing problems you can call upon the unmatched engineering skill of Chrysler-Amplex in powder metallurgy.

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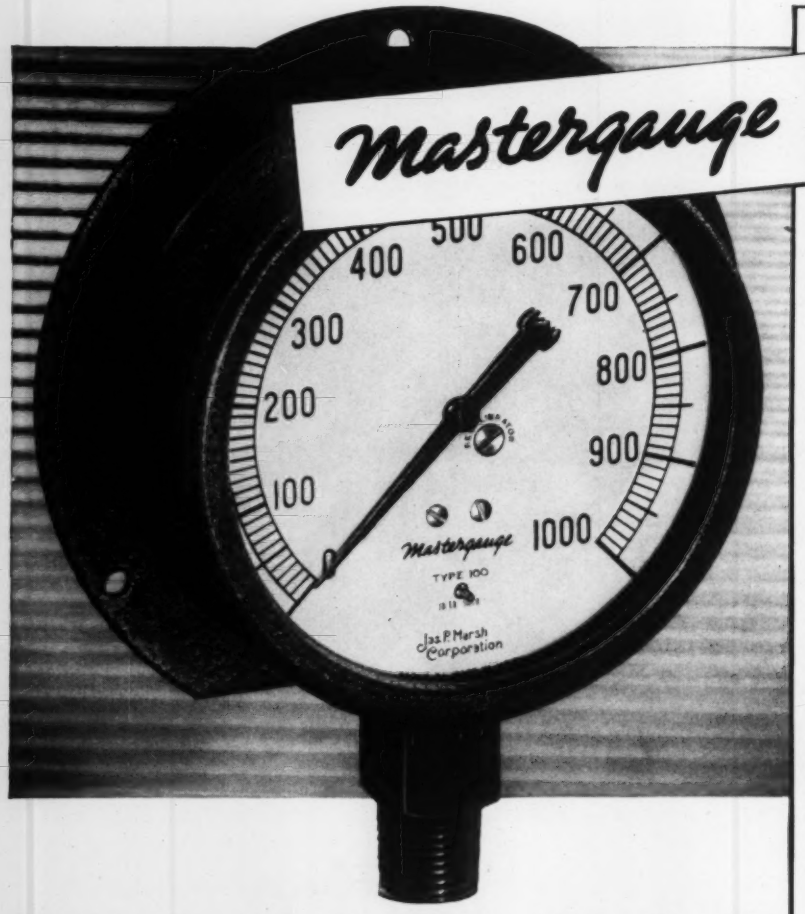

The leader has lengthened its lead!

From the day it was announced, the Marsh Mastergauge took the lead in the pressure gauge field. You are probably well aware of this . . . but do you realize that we have constantly given it plus qualities to still further *lengthen* its lead?

Look at the recent developments presented opposite. Unquestionably these are the three greatest strides in gauge development since the creation of the Marsh "Recalibrator."

Yes, the three basic gauge components have been brought to a remarkable stage of perfection in the Mastergauge. Certainly, for every critical service there is no gauge to compare with it!

Mastergauge is standard bearer for the world's broadest line of gauges and dial thermometers, each the best of their kind in the applications for which they are recommended. Ask for data covering your specific needs.

MARSH INSTRUMENT CO. *Sales Affiliate of Jas. P. Marsh Corporation* Dept. 29, Skokie, Ill.
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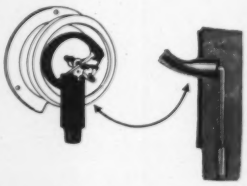
ONLY MARSH HAS THE "RECALIBRATOR"

MARSH

THE STANDARD OF ACCURACY

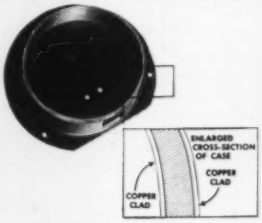


1—A better tube construction—

The Mastergauge always had the most effective joining of the bourdon tube to the socket . . . but . . . *one-piece construction is always better!* Welding these dissimilar parts posed a tough problem . . . but we finally solved it by a new process—the "Conoweld" process—exclusively ours. The photo of an actual section shows the perfect fusion. Socket, tube—even the end-piece—are fused into one leak-tight unit.

2—A better movement—

To convert the action of the bourdon tube into accurate pressure indication, the gauge movement must be rugged, practically frictionless, highly resistant to corrosion. A self-lubricating effect is achieved in the Mastergauge movement by using alternate stainless steel and monel—gears stainless, bushings "K" monel, and so on. A distinguishing feature is the "coined" sector gear. Note broad face of gear which results from this coined extrusion.

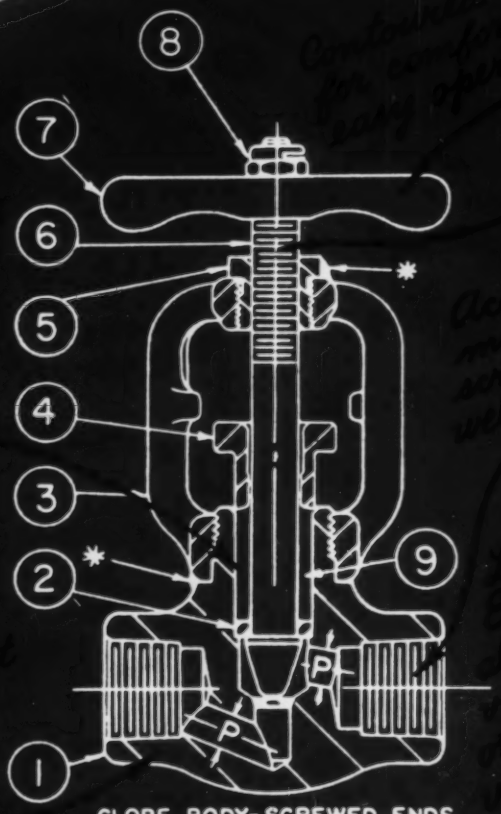


3—A better case—

Another development that has increased Mastergauge leadership is the new copper-clad, wrought steel case. The case has the strength of steel and the resistance to corrosion of copper. It is four times as strong as a cast iron case and one-third lighter. Final finish is a handsome corrosion resistant black enamel. Every case is fitted with Marsh safety blow-out plug—a typical advancement.

R.V.S.
Edward has the original and only complete line of carbon and stainless steel all-forged instrument valves. These features will save us money.
B. J. B.

ROCKWELL BUILT
Edward Valves



GLOBE BODY-SCREWED ENDS

LIST OF MATERIAL QUANTITIES ARE FOR ONE GLOBE OR ONE ANGLE VALVE WHERE A.S.T.M. SPECIFICATIONS ARE INDICATED THE LATEST REVISION APPLIES					
PIECE NO.	NAME OF PIECE	NO. REQ'D	MATERIAL	SPECIFICATIONS	EDW. MS. NO.
1	BODY	1	FORGED STEEL 0.30% MAX. C	A.I.S.I. C1029	114
2	JUNK RING	1	EVALLOY	A.S.T.M. A182 GRADE F6	212
3	YOKE	1	FORGED STEEL	A.S.T.M. A105 GRADE II	111
4	GLAND	1	FORGED STEEL EVALIZED	A.S.T.M. A105 GRADE II	111
5	YOKE BUSHING	1	BRONZE	A.S.T.M. B21	442
6	STEM	1	STAINLESS STEEL 13% CHROMIUM	A.I.S.I. TYPE 416	219
7	T-HANDLE	1	MALLEABLE IRON	A.S.T.M. A47 GRADE 32510	322
8	LOCK NUT	1	STEEL	COMMERCIAL	
9	PACKING		EVALPAK	HIGH TEMPERATURE PACKING	501
10	GLAND BOLT	2	FORGED STEEL EVALIZED	A.I.S.I. C1120	123
11	BOLT WASHER	2	STEEL		
12	BOLT NUT	2	STEEL-EVALIZED	A.S.T.M. A194 CLASS O	124
13	DISK	1	STAINLESS STEEL WITH STELLITED SEATING FACE	A.S.T.M. A193 GRADE B8F	257 481

EDWARD VALVES, INC.
SUBSIDIARY OF ROCKWELL MANUFACTURING CO.
EAST CHICAGO, INDIANA

FORGED STEEL INSTRUMENT
GLOBE AND ANGLE VALVES
GENERAL ASSEMBLY

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CHK'D: [illegible]
APP'D [illegible] DATE: [illegible]

CE-3430

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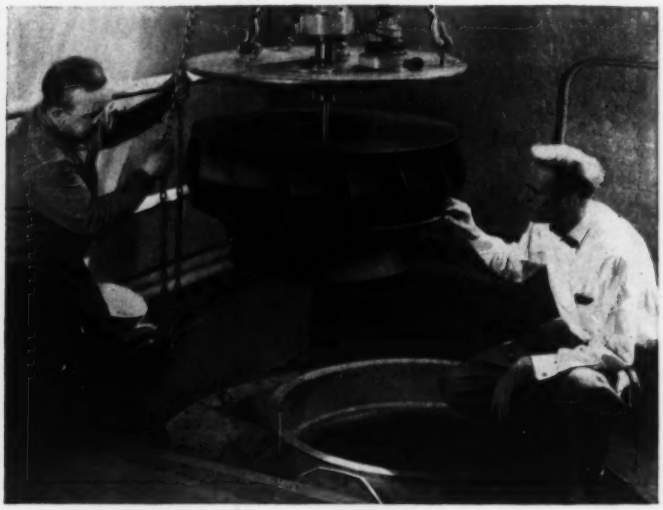

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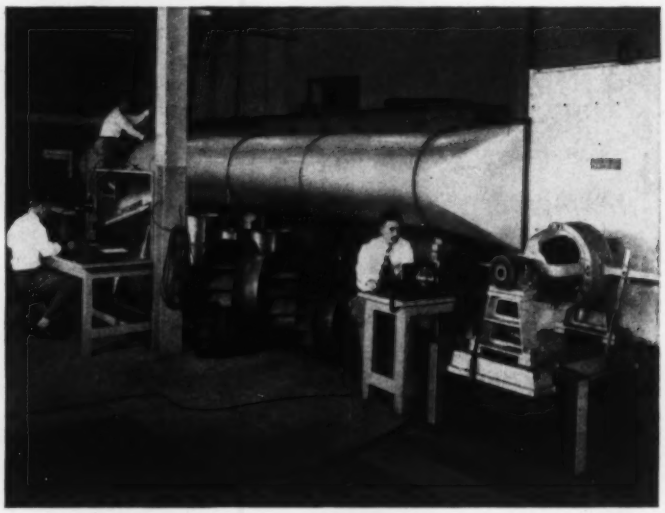

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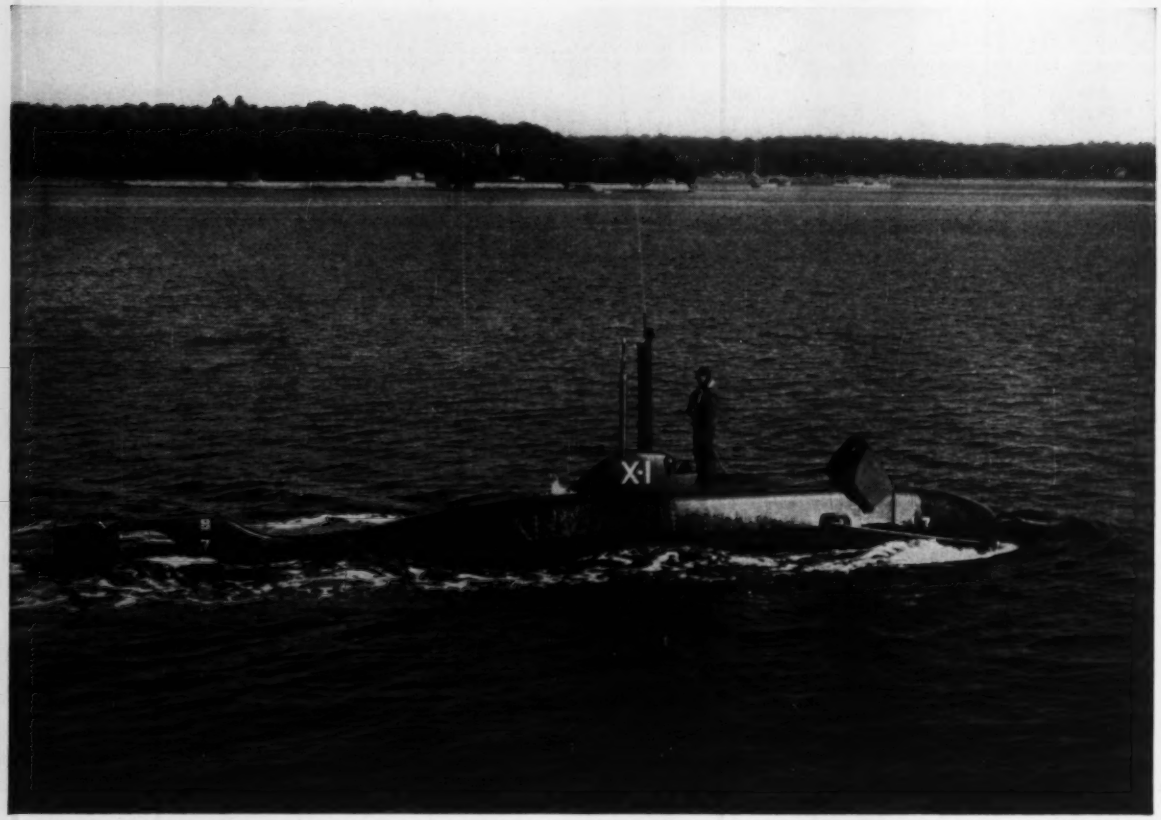

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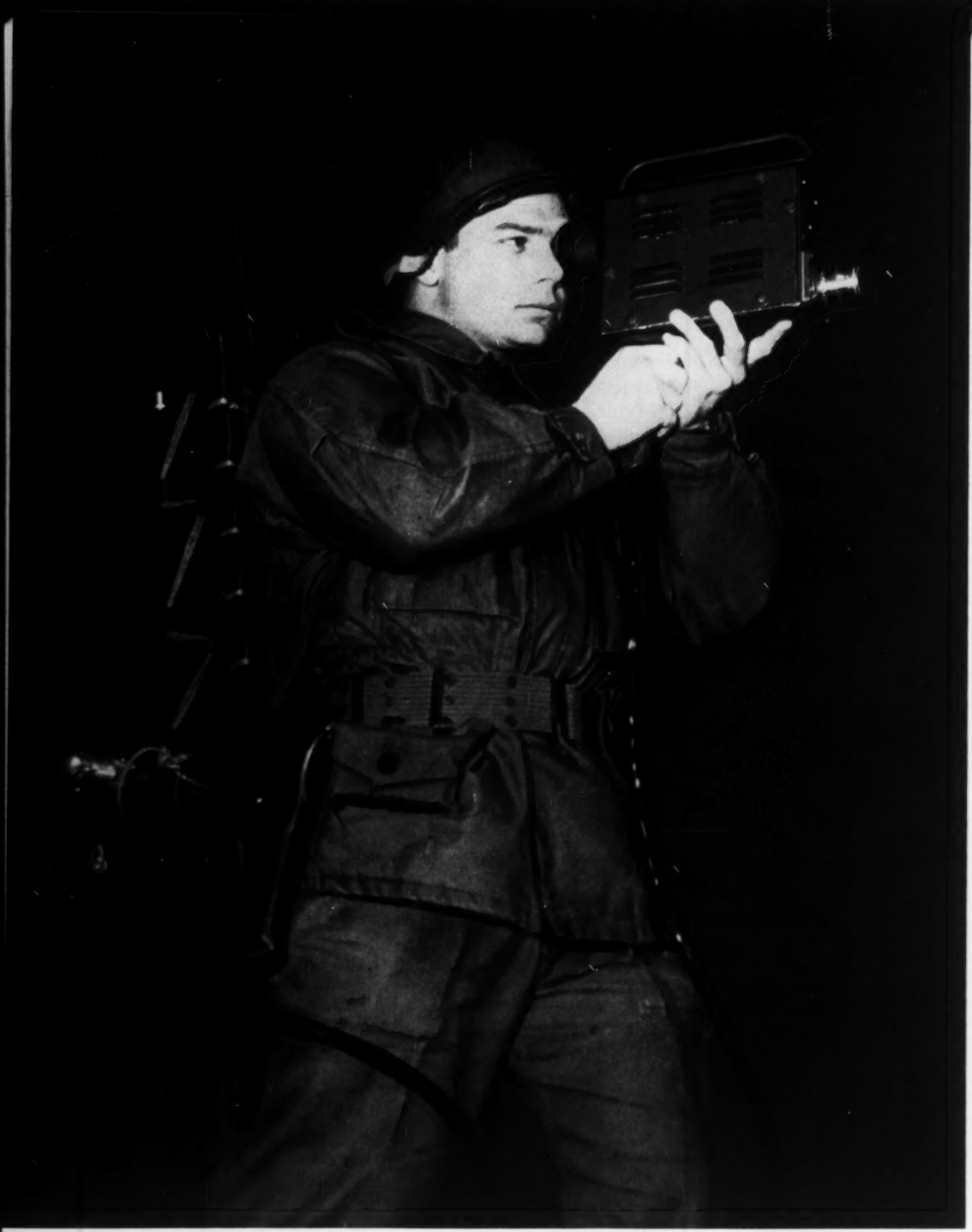

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George A. Stetson, *Editor*

MECHANICAL ENGINEERING

Taylor—and an Opportunity

It was appropriate that the Management Division of The American Society of Mechanical Engineers should pay tribute last month to Frederick Winslow Taylor, President of the Society in 1906, on the centenary of his birth. For without disparagement of others who have devoted themselves to the field of management, Taylor may be considered a symbol of the engineer manager.

Born in the environs of Benjamin Franklin's Philadelphia, cradle of liberty and the rights of man, of Colonial commerce and industry, and of the mechanic arts, Taylor was educated at Harvard, then a venerable institution founded to provide ministers and teachers for the leadership of a self-governing people. Until 1878 he was associated with William Sellers, manufacturer of machine tools, and until 1890 with the Midvale Steel Company, during which time he studied engineering at Stevens. After three years as a consultant in organization and management he returned to Bethlehem where, with the development of the Taylor-White tool steel, he increased the cutting capacity of the machine shops by 200–300 per cent. It was here that his ideas on shop management took concrete form. He left Bethlehem to expound principles which "he now saw would create a new era in the industrial world." He believed that he could do this to best advantage if he worked without charging for his services, so that during the last fourteen years of his life he was free to assist anyone who was sincerely desirous of carrying out his methods. He died in March, 1915.

The American system of interchangeable parts manufacture in Taylor's boyhood was making use of steam and water power, of special machinery and machine tools, of jigs, fixtures, and gages. It was ready for further developments that characterize low-cost mass production and the increases in the productivity per man-hour which pave the way for shorter hours, higher wages, and an abundance of material goods. Urging these great developments forward were business men, artisans, inventors, and engineers who led the Nation into an industrial economy which has absorbed millions of workers and produced fabulous wealth with ever-broadening reliance on natural and social science. Of these developments Taylor stands as a symbol.

It was typical of Taylor that he should draw on many sources of knowledge and that he should be misunderstood and abused. When he became interested in improving machining processes it was natural for him to employ a young metallurgist from Stevens, Maunsel White, to develop new cutting materials, and a Norwegian mathematician, Carl Barth, to assist in the task of deriving relationships between the numerous variables of speed, feed, depth of cut, tool shape, and the like.

The paper on the "Art of Cutting Metals" which Taylor delivered in 1906 as his ASME Presidential Address occupied 300 pages and 24 folded inserts in Transactions ASME. It represented the work of 26 years. Of it Henry R. Towne said, "The work of Mr. Taylor and his associates has lifted it (the art of forming and tempering tools) at once from the plane of empiricism and tradition to the high level of modern science and apparently has gone far to reduce it almost to an exact science. In no other field of original research that I can recall has investigation, starting from so low a point, attained so high a level as the result of a single continued effort."

Not so quickly appreciated was Taylor's early work in the field of management. His ASME paper of 1895, "A Piece Rate System," in spite of the subtitle, "Being a step toward the partial solution of the labor problem," failed to arouse enthusiasm, and it was not until the 1903 paper, "Shop Management," that his fellow members began to see significance in this phase of his work.

From the dawn of civilization until the industrial era the unit of time which has affected men most has been the year with its seasons. With the factory came the routine of the day. With Taylor emphasis was on minutes—more minutes to be accounted for in a day than there are days in a year. The stop watch became a dreaded symbol and the basis of a Congressional inquiry. Taylor and the Taylor system were misunderstood and abused. But Taylor himself set two conditions "without which scientific management cannot be said to exist," first, that "both sides take their eyes off the division of the surplus as the all-important matter and together turn their attention toward increasing the size of the surplus," and second, that special attention be given to "the accurate study of the motives which influence men."

On the basis of these two conditions, Taylor and those who think as he did become not the enemies of labor but the benefactors of labor and of all of us. Surely the achievements of American industrial economy bear out this statement, even if the ultimate goal has not as yet been reached.

With Taylor as its symbol and his ideals as its guide, the ASME Management Division has the opportunity and the capacity to attain this goal.

Manufacturing Synthetic Lumber in Germany

Production begun in United States—rapid expansion possible with equipment and techniques developed in West Germany

By A. Elmendorf,[1] W. Klauditz,[2] and A. Lühning[3]

THE beginning of a synthetic-lumber or shaving-board industry in the U. S. has been made, and it is anticipated that the coming years will see substantial and rapid progress in the manufacture of such products in this country. They will be referred to as shaving boards in this paper inasmuch as they are made of specially cut shavings bonded together.

Shaving boards are now being manufactured in the form of large slabs that may be 6 ft × 12 ft in size and $^3/_4$ in. thick. They differ from lumber sawed from logs in that they have the same strength properties in both the length and breadth directions, and in that they do not shrink or expand noticeably with changing atmospheric conditions. The shaving board has evolved out of the manufacture of so-called chip or particle boards and must not be confused with the latter.

Character of Shaving Board

The wood-shaving board consists essentially of flat shavinglike flakes of wood bonded together with synthetic resins to produce thick panels that are subsequently generally faced with veneer when used in the furniture industry, but are simply varnished or lacquered when used for doors and for decorative purposes in display windows, and for interior paneling. The boards generally have a flakelike surface which has been found attractive for many uses. In furniture, shaving boards are used to replace lumber for the application of fancy or exotic veneers. The conventional cross-banding-veneers may be used between the shaving-board core and the face veneer, but for low-cost furniture the cross-banding is often eliminated and the face veneers are applied directly to the shaving-board surface.

Some of the products made abroad have a uniform composition throughout their thickness. The edges of such panels can be shaped with appropriate high-speed cutting tools and then finished.

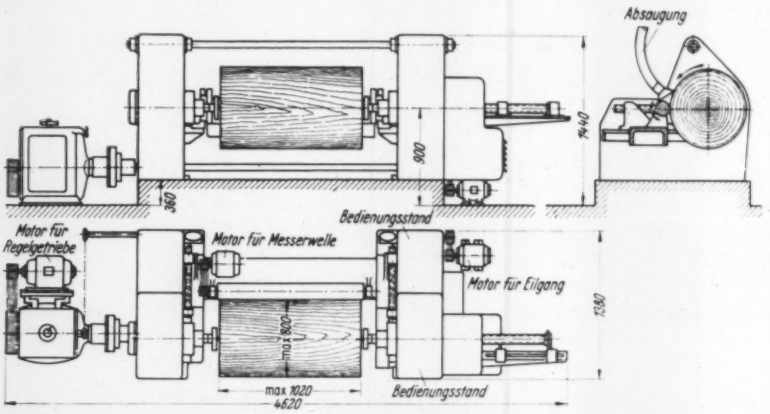

Fig. 1 Diagrammatic illustration of the wood-shaving cutter built by A. Roller. This machine is based upon the lathe principle. The wood block is rotated between lathe centers. A knife cylinder operating at high speed moves slowly against the block and in doing so cuts shavings whose length is determined by the position of the scoring knives on the cylinder. Maximum length of wood block: 42–50 in. Power: 20 kw.

Special Machines Developed

Special machines have been developed for cutting the thin, flakelike shavings commonly seen on the surface of shaving boards. Some of the factories abroad now manufacture the boards in 3 plies, the outside or exposed ply being made of shavings that are more or less whole and thereby provide an attractive flakelike surface. The interior of the panel is often made of comminuted chips or shavings and frequently a lower resin content is used in the core. The shavings range in length from about $^1/_2$ to $1^1/_2$ in., and their thickness may

---

[1] President, Elmendorf Research, Inc., Chicago, Ill.

[2] Doctor of Engineering, Director, Forest Products Laboratory, Braunschweig, Germany.

[3] Doctor of Engineering, Laboratory Director, Western Nu-Ply Corporation, South Bend, Wash.

Contributed by the Wood Industries Division and presented at a joint session of Wood Industries Division and Forest Products Research Society at the Diamond Jubilee Annual Meeting, Chicago, Ill., November 13–18, 1955, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Condensed from Paper No. 55—A-190.

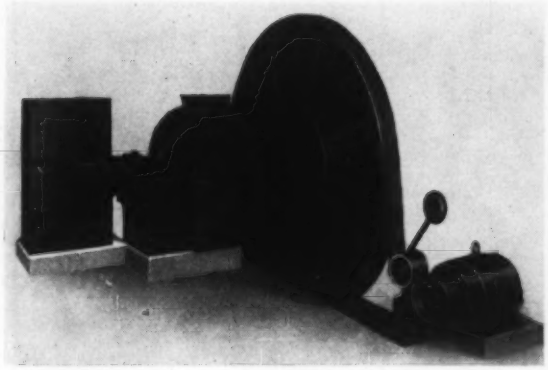

Fig. 2 Disk machine for cutting wood shavings, made by W. H. Ortmann. In this machine the wood blocks are dropped into a hopper consisting of rotating compartments and are there pressed against the disk with a ram. Shaving length is determined by the spacing of the scoring knives. Maximum length of wood blocks = 19 in. Power: 25 kw.

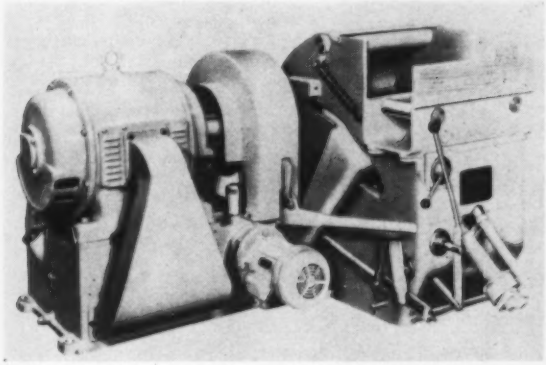

Fig. 3 Machine for cutting wood shavings, made by F. Meyer & Schwabedissen. The knives are mounted on a cylinder and are held in position with hydraulic pressure. The knife-edges are recessed to produce shavings of desired length. Intermittent feed. Maximum length of wood blocks: about 39 in. Max diameter of wood blocks, about 8 in. Power: 26 kw.

be about $^1/_{100}$ in. Width of the shavings varies greatly, the important feature lying in the fact that, contrary to shavings produced in an ordinary planer wherein the cutting action takes place at an acute angle to the botanic fibers of the wood, in the shavings produced on the special machines the botanic fibers are parallel to the surface of the flakes.

Most of the boards manufactured abroad have a specific gravity of about 0.5 to 0.6. In addition to their use in the furniture industry and for wall paneling, they are also being used in the construction of freight cars.

The thickness of the panels ranges from about $^1/_4$ to $1^1/_2$ in., and the modulus of rupture from 2300 to 2800 psi. The boards have good nail and screw-holding power, and excellent dimensional stability. They can be machined on ordinary woodworking machines. The increase in thickness after 24 hr in water is about 5 per cent.

Cord wood and sticks that may not be more than 2 or 3 in. diam are used as the raw material. Sawmill waste in the form of slabs and edgings can be converted into the shavings, but conventional comminuted waste, such as sawdust and shavings, is not satisfactory, although some of such waste is added at times to the fibers or shavings used for the core.

Considerable research work was conducted in Germany after the war by manufacturers as well as by research laboratories such as the Institute for Wood Research at Braunschweig to produce superior wood-shaving and particle boards. These investigations showed that superior boards in both strength and other physical properties can be obtained if the wood shavings are cut specifically for the manufacture of boards. It was found that when the shavings are cut parallel to the grain of the wood, the cost of the board of a given strength can be reduced materially. Most of the shaving boards are now being made of shavings derived from fir or other soft woods.

An Expanding Industry in West Germany

Lightweight boards having a density of 0.3 can be made and are being made to a limited extent for use as insulation boards and as wallboards. The volume of boards produced of such low density is, however, relatively small.

The manufacture of wood-shaving boards is a rapidly expanding industry in West Germany. In 1954 the industry had a capacity of about 3,500,000 cu ft, and the output for 1955 is expected to be about 5,600,000 cu ft. Besides soft woods, the industry is now also using beech and birch, as well as material from the lumber and veneer industries.

At the present time there are about 35 shaving-board operations in Western Germany. Four of these are producing, each having a capacity of 1750 to 3500 cu ft per day. These four operations produce about 50 per cent of the total output. Most of the smaller operations have a capacity ranging from 350 to 1050 cu ft per day. The product is being improved continually and the boards have found excellent acceptance among carpenters and furniture manufacturers.

Manufacturing Processes

Two different systems of forming and pressing the board are in use abroad, as follows:

Hot-Plate Process. In the normal process, which accounts for most of the production abroad, the shavings are bonded together between hot horizontal plates under hydraulic pressure. The best-known among these is the Behr process which was developed by the Behr Furniture Company of Wendlingen. The Novopan process developed by Fahrni also uses a hot press.

Extrusion Process. This process was developed in the furniture factory of Otto Kreibaum and two of his licensees. In this process the resin-coated shavings are extruded as a continuous mass between parallel hot plates.

The physical properties of boards made by pressing in a hot press are different from those made by the extrusion process. The latter requires cross-banding with veneer in order to obtain satisfactory strength and dimensional stability in the direction of the extrusion, whereas the boards made by hydraulic pressure are inherently strong and do not require surface reinforcement.

Novopan Board. The Novopan board is formed in a frame which receives the shavings. A mechanical spreader which moves back and forth across the frame

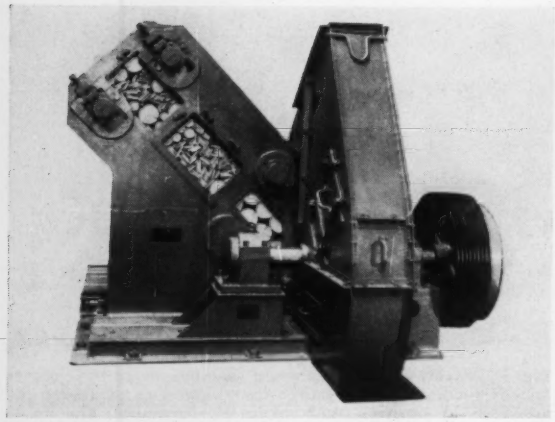

Fig. 4 Disk machine for cutting wood shavings made by Heinrich Wigger & Co. The magazine takes blocks 13 in. long. It is inclined at 45 deg to the cutting disk which is provided with four knives. The blocks are clamped between two chains that push the contents against the rotating disk. Continuous feed. Scoring knives determine the shaving length. Power: starting, or with dull knives, 50 kw; operating with sharp knives, 22–23 kw.

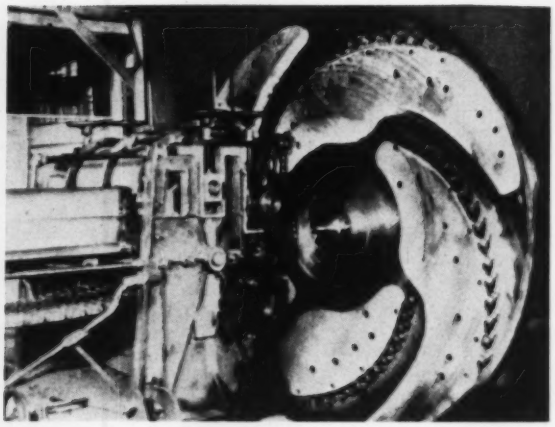

Fig. 5 Disk machine for cutting wood shavings, made by Anthon & Söhne. The machine is intended primarily for cutting veneer waste into strandlike shavings. It is provided with numerous hard metal knives whose width determines the length of the shavings. Continuous feed. Diameter of the disk, about 80 in. Power: starting, 18.5 kw; operating, 11 kw.

distributes the shavings in successive layers. After prepressing at room conditions, the mats are transported to a charging mechanism on metal cauls. The charging mechanism loads all of the press openings simultaneously. The pressing time may be from 15 to 20 min, depending upon the thickness. The factory at Göttingen-Grone, producing Novopan boards, turns out about 66 tons per day.

Other factories, such as that of the Norddeutsche Holzwerkstoff Gesellschaft at Triangel and the Moralt plant at Bad Tölz, form the boards as a continuous mat. These mats are cut to length and prepressed separately before hot pressing. Both the Behr and Novopan processes are therefore discontinuous or intermittent in the pressing stage, whereas in the Kreibaum process the boards are made in a continuous stream which is cut to length after formation and extrusion.

Manufacturing Steps

The following steps characterize the hot-plate systems for manufacturing shaving boards:

Preparation of Raw Wood. In order to obtain adequate moisture for easy cutting of the shavings and also to facilitate debarking, the raw wood is either sprinkled in the wood yard or is stored in hot water at a temperature of 140 to 160 F. Transportation from the log yard to the hot-water pond is mechanized. The optimum moisture content for cutting the shavings is about 70 per cent. With this moisture content the shavings are smoothly cut and a minimum amount of energy is required. Moreover, the amount of fines is reduced to a minimum and the life of the cutting knives when cutting at 70 per cent moisture is greater than that when cutting dry wood.

As the presence of bark reduces the strength and quality of boards and vitiates the surface, besides decreasing the cutting life of the knives, more and more plants are shifting over to bark removal. Mechanical debarking is now commonly practiced.

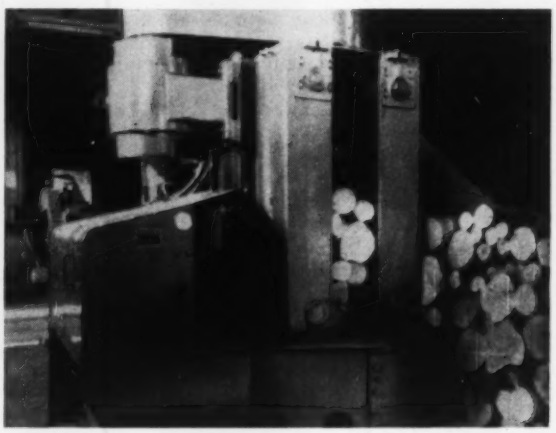

Fig. 6 Disk machine for cutting wood shavings, made by Albert Bezner. The disk is 60 in. diam and is provided with 10 knives. The wood blocks are placed in a vertical hopper and are fed downward between two chains. Continuous feed. Scoring knives determine the length of shaving. Maximum length of wood blocks, 13 in. Power: for the disk, 29 kw; for the hopper chains, 1.5 kw.

The wood of cord-wood length is first cut into blocks from 1 to $1^2/_3$ ft long to fit the hopper of the shaving cutter. A magnetic detector locates nails and other foreign metal objects that must be kept out of the shaving cutter.

Cutting the Shavings. Three different methods for reducing the raw wood to particle size or shavings are involved in the manufacture of shaving boards, but of these the second method, namely, that of cutting the shavings by means of moving knives, is the most important:

Fractured Particles. For this purpose ordinary chippers are used or wood hogs, followed by hammermilling. Coarse particles or chips produce a rough surface unless faced with flakelike shavings. Such particles are used for the core of some boards.

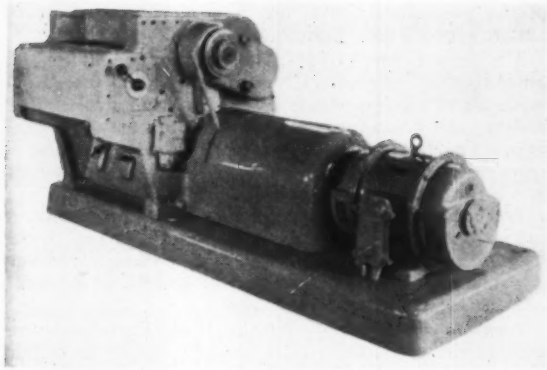

Fig. 7 Machine for cutting wood shavings with cylindrically mounted knives, made by H. Rottmann. The wood blocks are dropped into a hopper from where they are pressed against the rotating knives with four pusher bars mounted on a crankshaft. Maximum size of wood blocks, 22 × 8 × 3 in. Power: starting, 60 kw; operating, 37 kw.

in which small blocks of wood waste are thrown by centrifugal force against a rim provided with knives. As the blocks sweep over the knife-edges they are reduced to fiberlike particles that are more fibrous than the particles coming from a hammermill.

As previously stated, the shavings produced by the shaving method are generally from about $^1/_{100}$ to $^1/_{50}$ in. thick. When the boards are intended for decorative uses, it is important that the surface shavings be mutilated as little as possible. In that case the surface shavings are generally thinner than those used for the core. The surface shavings are therefore separated from the coarser core shavings.

The prepared shavings are stored in special bins from which they are drawn mechanically and automatically as required. As the shavings weigh very little and their bulk is great, special storage bins are required.

Drying the Shavings. Various mechanical means for drying wood shavings have been perfected and are now in use. The following four types of driers have been found satisfactory:

Drum Drier. In this drier the particles are fed in at

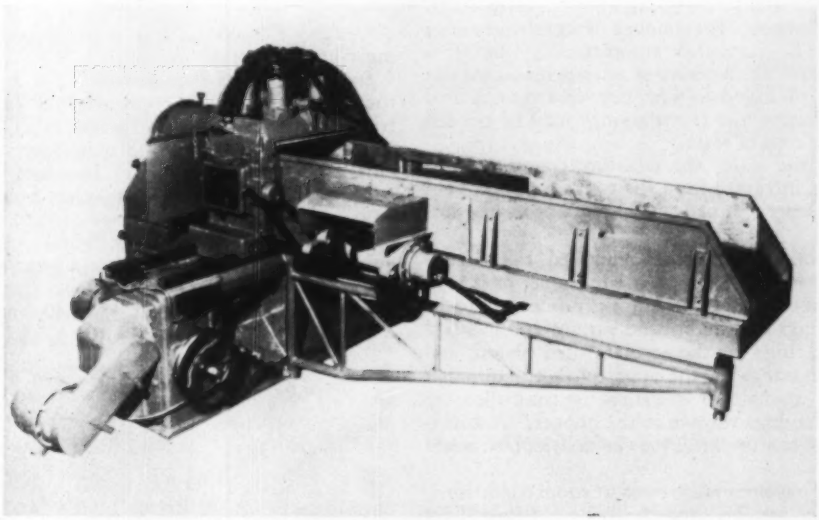

Fig. 8 Machine for cutting wood shavings, made by W. Grupp. In this machine the ends of the wood blocks are pressed outward against knives mounted on the inside of a rim attached to a disk. The wood blocks may be of any length as they are moved forward in steps and only the end 5 in. are cut at a time. Maximum diameter of wood blocks about 12 in. Power: 24 kw.

Shavings. The raw wood is cut with knives, the edge of the knife generally moving across the grain of the wood. The thin flat shavings that are produced can be made of various thicknesses and lengths. Machines for this purpose are either of the disk or cylinder type, as shown in the accompanying illustrations. The capacity of the machines varies from about 500 lb to more than 1 ton per hr. Many variables affect the cutting rate besides the power of the drive such as thickness of shaving, moisture content, and condition of the knives.

Fiberlike Particles. Fibrous particles may be produced in conventional grinding machines, as used in the paper industry. However, a special machine is also available

one end of a long cylinder, and they fall through a stream of hot air as the cylinder slowly rotates. The hot air may come directly from various types of burners.

Turbodrier. In the turbodrier the shavings are supported on plates at the rim of a large horizontal disk; the disks may be more than 20 ft diam and they rotate slowly around a vertical shaft. Hot-air currents set into motion by a central blower pass over the shavings as they fall automatically from one disk to the next lower one. The plates supporting the shavings are tilted at a certain point in the rotation of the disk, thereby dropping the shavings onto the next lower disk. Drying proceeds slowly, but those who use the process claim uniformity in the result.

Belt Drier. In belt drying the shavings are transported horizontally on link chains and are there subjected to hot-air currents.

Flash Drier. In the flash drier the wood particles are carried upward in a stream of hot air and drying takes place very rapidly. Heat is provided by means of steam, hot water, hot air, or hot waste gases from the factory furnace. Most of the larger operations use either hot water or steam. In drying the shavings, the moisture content is reduced from about 70 down to 3 or 4 per cent.

Mixing. The proper application of the resin to the shavings is an important step in the manufacture of the shaving board. Only about 6 to 8 per cent resin is generally used when urea resins are employed, and an even smaller percentage when phenolic resins are used. Considerable experience in the art of coating the shavings has now been acquired, and both batch and continuous mixers are being used.

Types of Resins Used. Most shaving boards are made with resins of the urea-formaldehyde type. The viscosity of the resin permits fine spraying. It is customary to add a water repellent to improve the water resistance.

The resin is usually applied to the shavings as a fine spray while the shavings are being agitated with rotating arms in the mixer. The amount of resin that enters into the mixer is controlled automatically, and if a batch mixer is used the amount of resin is measured out for each batch. While 6 to 8 per cent urea resin is used for the core particles, the face shavings may be bonded with 9 to 12 per cent of resin.

After adding the resin, the moisture content of the shavings will be increased from their original 4 per cent to about 10 to 11 per cent or 13 to 14 per cent for the surface shavings.

Forming the Mat. As previously remarked, the mat for each board is formed in an appropriate frame, or it may be formed continuously. When a 3-ply board is to be made, the shavings for the bottom surface are first laid down. The shavings for the core are then placed, and after this, the shavings for the upper surface. In batch formation, the amount of shavings is controlled by weighing the shavings thrown in the hopper. Automatic weighing is readily achieved in continuous board formation.

After the mat has been prestressed at room conditions, it may be further weighed and the volume adjusted by removing surface particles, if necessary, to obtain the desired thickness.

The speed of continuous formation depends upon the thickness of the mat desired and the capacity of the press. It generally ranges from 6 to 15 fpm.

Pressing. In order to reduce the opening between the hot plates of the press it is necessary to reduce the thickness of the mat by prepressing. In the batch system, prepressing is done while the shavings are retained in the felting box. After prepressing, the frame is removed and carried back to the forming station. In continuous formation, the mat is cut to length by a flying saw and each mat is then prestressed in a cold platen press. The resultant mat is then trimmed along the long edges, whereupon it is transferred to the mechanical loader of the press.

Special presses have evolved for the manufacture of shaving boards. The press platens are generally thicker and stiffer than those of conventional hot-plate presses. The presses may have from 10 to 20 openings. Many of the presses are 4 ft × 8 ft in size, but recently constructed presses have platens as large as 6 ft × 13 ft.

The presses close rapidly, and the rate of loading and unloading is automatically controlled and integrated with all other operations of the pressing cycle. The loading and unloading, and press closing may require 1 min. The board thickness is determined by means of stops fastened to the press platens. The platens are now generally heated with hot water.

After the boards have been removed from the cauls or carrier plates, the latter are cooled and returned to the forming station. The return system is mechanized and is synchronized with the forming or felting machine and the press with its accessories.

Trimming and Sanding. Although thickness stops are used in the press, the panels must be sanded to obtain exact thickness. After cooling, the panels are trimmed to size and then sanded to the final thickness in a drum sander.

Economics of Board Manufacture

Space Required. For a capacity of 33 tons per day, 12,000 sq ft of floor space is required and 10,000 sq ft of storage space. A capacity of 66 tons per day requires about 16,000 sq ft of floor space and correspondingly greater storage space.

Energy and Heat Requirements. The manufacture of a ton of shaving boards requires about 250 kwhr of electrical energy and 5700 lb of steam.

Cost of Labor. About 18 man-hours of labor are required per ton of product. The well-known German authority, F. Kollmann, states that from 19 to 30 man-hours are required per cubic meter of product of which 65 per cent is productive labor. Small operations may require 25 hr per ton, and where a great deal of manual labor is involved, the man-hours may exceed this. Wages generally range from 35 to 40 cents per hr.

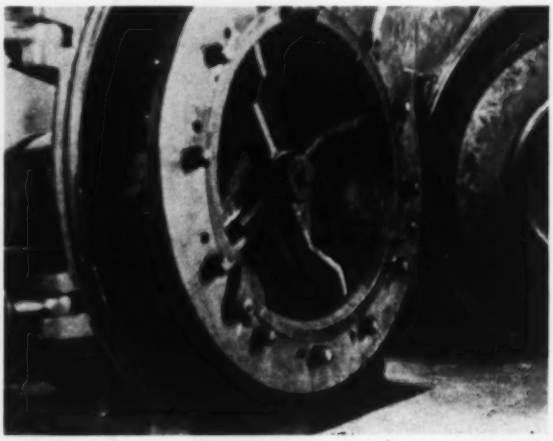

Fig. 9 Wood-shaving cutter made by Ludwig Pallmann. This machine was developed to reduce short blocks trimmed off board ends that could heretofore only be reduced in a hog and hammermill. The blocks are dropped into a hopper from where they go to the center of the machine, and are thrown outward by four rotating arms, and through centrifugal force are pressed against knives as they are pushed around by the arms. The resultant fibers or shavings are cut at various angles relative to the wood grain. Power: 48 kw for the cross arms; 24 kw for the bowl.

Ceramics as Basic Engineering Materials

Ceramic products are defined as those made of inorganic, nonmetallic material which are usually subjected to high temperatures during fabrication. This includes a wide range of products, but of more importance to the engineer, it embraces a wide range of unique and useful properties.

By E. J. Smoke[1] and J. H. Koenig[2]

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Among the unique properties of ceramic materials is refractoriness, that is, resistance to high temperatures. Fig. 1 shows the melting temperatures of some ceramic materials along with those of several metals. The melting temperatures of the basic crystalline phases of most ceramic materials are quite high starting in the range of 3000 F; iron melts at 2895 F. Glasses are ceramic materials also, but they cannot be considered as refractories. This is because they are not compounds but rather behave as supercooled liquids whose viscosity is extremely high at room temperature; thus they have softening ranges rather than melting temperatures.

Melting Temperatures

Ceramic products are being manufactured whose melting temperatures are lower than 3000 F, principally due to a high glass content. Ceramics made of clinoenstatite, titania, silica, mullite, forsterite, alumina, spinel, zircon, beryllia, zirconia, magnesia, and thoria are oxide-type ceramics. All but the first two are used as refractory materials where high-temperature processing is involved; that is, as furnace liners in heat-treating of metals, recovery of metals from their ores, alloying of metals, recovery of petroleum products from crude oil, nuclear applications, and the like. Thoria has a very high melting point, however; it is radioactive. Silicon carbide is used as a refractory and to a large extent as kiln furniture. Boron carbide has a high melting temperature but it is used only in special cases. Other carbides, sulphides, nitrides, and borides have still higher melting temperatures but have only been made experimentally or on a very limited scale because of the rarity of some of the elements involved and the protective atmosphere necessary in using these materials. They are being used experimentally in heat-engine parts such as jets, rockets, and so on.

The highest melting metal is tungsten which melts at approximately 6100 F. Zirconium, tantalum, and hafnium carbides, and graphite have melting temperatures above this with hafnium carbide having the highest melting temperature known of approximately 7520 F.

Ceramic products are generally a mixture of one or more crystalline phases with glass, the latter material varying up to approximately 45 per cent. This glass content affects the refractory properties. Included in Fig. 1 is a graph of the "safe continuous operating temperature" of some of these ceramics. The best glasses can be used continuously only up to approximately 900 F. Steatite and forsterite can be used continuously to 1830 F without distortion when used as technical ware such as high-frequency insulation, or whenever dimensional tolerances in the range of ±1 per cent are prerequisite. However, forsterite, when used as furnace parts, operates successfully up to 3000 F. Normal porcelains have been used up to 2185 F. Zircon, whether used as technical ceramics or as a refractory, operates very well up to 2650 F. Silicon carbide, which is used as furnace parts, stands up very well to approximately 2750 F in air. Silica is used principally as a refractory in open-hearth furnaces where the temperature approaches 3000 F. Mullite refractories are used continuously up to 3200 F.

The effect of glass content and/or an additional crystalline phase or phases is illustrated by the safe continuous operating temperatures of several alumina bodies. A body containing 86 per cent alumina can be used continuously up to 2550 F; another containing 96

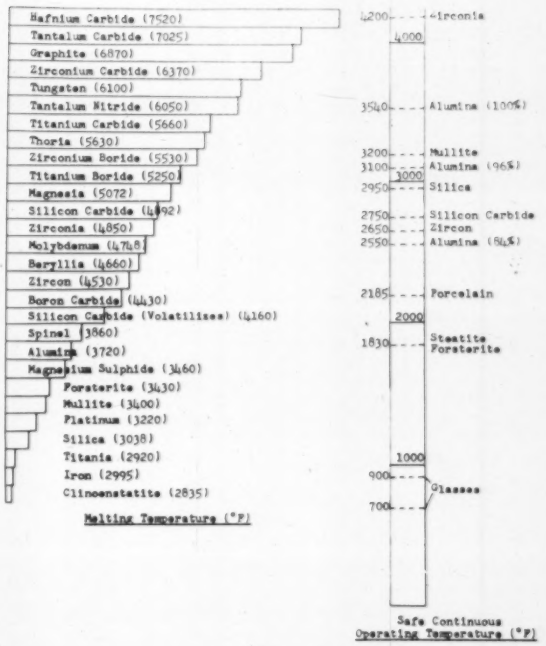

Fig. 1 Thermal properties of ceramic materials and metals

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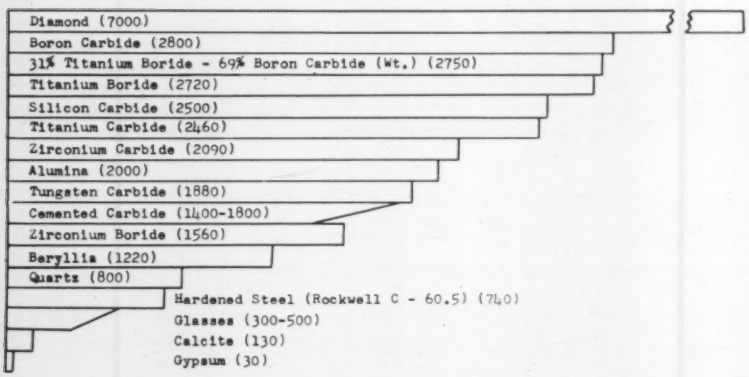

Fig. 2 Hardness (Knoop scale) of ceramic materials ranging from 30 to 7000

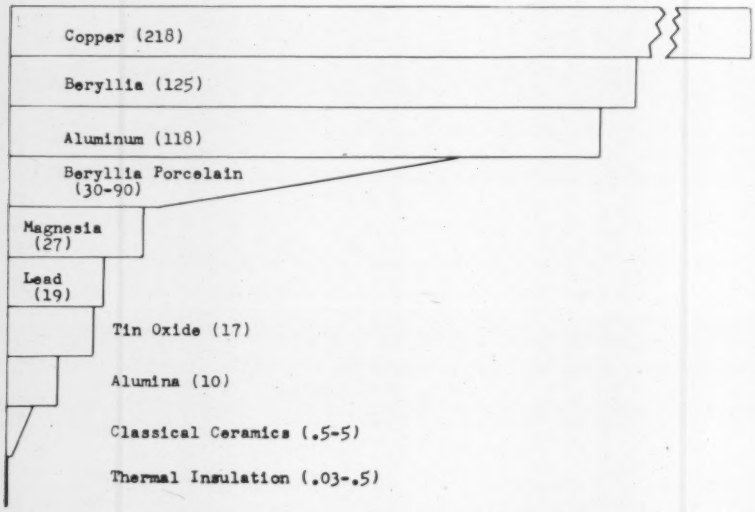

Fig. 3 Thermal conductivity of ceramic products Btu/hr sq ft/(deg F/ft), at 140 deg

per cent, up to 3050 F; while pure recrystallized alumina, that is, containing no glass, can be used continuously up to 3520 F. These are used as furnace parts and technical ceramics of close dimensional tolerance and for high-temperature vacuum applications.

Zirconia provides a very high safe continuous operating temperature (circa 4200 F) and in the fused stabilized form is used as furnace parts.

Alumina and zirconia are applied to metals in thicknesses up to 0.010 in. by the flame-spray process. This type coating shows promise for heat-engine parts, abrasion-resistant coatings, and erosion-resistant parts.

Thus ceramics provide a wide selection of refractory materials for use as furnace parts or as technical ware and the choice depends upon end use and economics.

Hardness

Hardness is another property unique to ceramics covering the range from 30 on the Knoop scale for the mineral gypsum to 7000+ for the diamond as shown in Fig. 2. Glasses range from 300 to 500. The hardest metals are hardened steel at Rockwell C 60.5 which is approximately 750 on the Knoop scale. Several ceramic materials fall in this range also but the majority possess greater hardness. The cemented carbides are made of synthetic ceramic materials such as tungsten, titanium, and tantalum carbides whose Knoop hardness numbers range from 1400 to 1800. They are used as tools for machining metals to close dimensional tolerance.

Alumina has a value of 2000 and is used as a grinding and lapping compound, and as the abrading media in grinding wheels for machining steel. A relatively new application is as tool bits for machining metals. This extreme hardness and the fact that this type ceramic can be fabricated to extremely close dimensional tolerance lends itself as wear-resistant parts such as gages, bearings, thread guides, nozzles, and technical ware in general.

Silicon carbide, with a Knoop hardness of 2500, is one of the most important abrasives in terms of lapping and grinding, and as grinding wheels. It lends itself best for fabricating very hard dense materials such as ceramics, including cemented carbides, cast and chilled iron, and nonferrous metals.

Titanium boride has a value of 2720 and boron carbide of 2800; this latter was the hardest synthetic material until quite recently. However, in the past year man has made the first synthetic diamonds. Diamond is the hardest known material. It is marketed in many grain sizes and in many type grinding wheels. Its extreme hardness and durability make this material of economic significance even though the initial cost is quite high.

The property of extreme hardness has made ceramic abrasives actually indispensable in the fabrication of metals and other materials. There are no substitutes for ceramic abrasives.

Thermal Conductivity

Another engineering property of extreme importance is thermal conductivity. Again, ceramic products cover a wide range from near zero up to 125 Btu as shown in Fig. 3. In the very low range of thermal conductivity a variety of thermal-insulating materials are manufactured from mineral products such as asbestos, magnesia, diatomaceous silica, refractory clays, mineral and glass wools, and synthetic fibers; these are used from below room temperature to above 3000 F as drier, oven and furnace liners and backings, pipe covering, and numerous other applications.

Ceramic products in general are characterized by low thermal conductivity and approximately 98 per cent of all products manufactured have thermal-conductivity values no higher than 5 Btu. This is due not only to the property being inherently low but also to the large per cent of pore space or voids which are present in some of these materials. It has been noted in the foregoing that magnesia is an excellent thermal insulator yet Fig. 3 shows that it has a value of 27. The former value is for a very porous material while the latter value is for one containing no more than 1 per cent pore volume. Thus all ceramics possessing thermal-conductivity values above 5 Btu are nonporous materials. Alumina ceramics have thermal-conductivity values up to 10 Btu.

Tin oxide has a value of 17 but has not been used industrially to any extent in ceramic bodies. The metal lead has a value of 19. Magnesia's conductivity as a dense ceramic, as mentioned, is 27 and has been used as electrical insulation in vacuum tubes. Above this range the only ceramic material is beryllia and its value is 125 Btu as compared to aluminum at 118 and copper at 218. By combining beryllia with other ceramic materials a range of porcelains can be made whose thermal conductivity ranges from 90 to 30 Btu. Some sparkplug and high-frequency insulators, where high thermal conductivity is of importance, have been made from beryllia and beryllia porcelains. However, because of the toxic effect of this material, its use has been limited. It is now considered that this material can be used safely when the proper precautions are taken.

Thus ceramic products can be made which cover the wide range of thermal conductivity from values of 0.05 to 125 Btu, which is from the best thermal insulators to conductivities exceeding that of the metal aluminum.

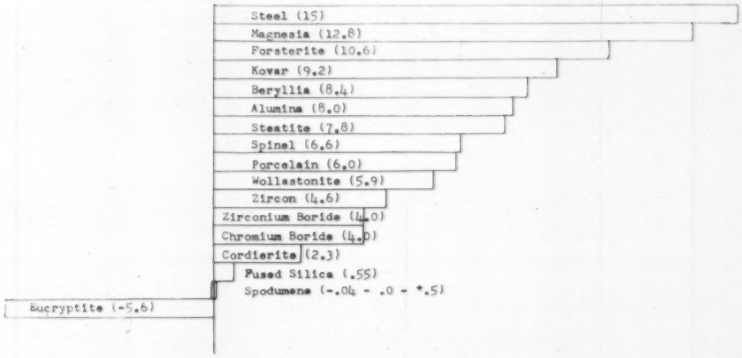

Fig. 4 Coefficient of linear thermal expansion of ceramic materials; room temperature, 700C (1292 F)

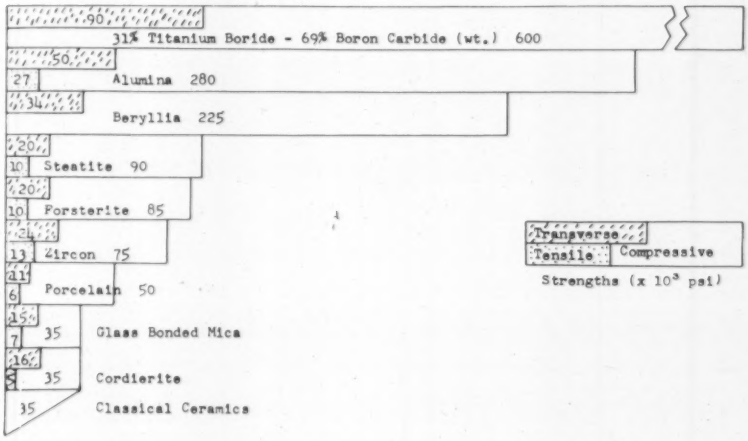

Fig. 5 Tensile, transverse, and compressive strengths of ceramic materials

Thermal Expansion

Ceramic materials are manufactured which cover the range of linear thermal expansion from 0.5–13 $\times 10^{-6}$ in/in/deg C between room temperature and 700 C as shown in Fig. 4. Magnesia has the highest thermal expansion at 12.8. Low-carbon steels have values in the range of 15 over the same temperature range while copper is approximately 17. One of the prime applications of a desired high thermal expansion in ceramics is in glass-to-metal and ceramic-to-metal seals for electron tubes and other vacuum-tight, strong, high-temperature seals. There are two types of seals. The compression type is exemplified by copper and forsterite or alumina, and Kovar and alumina. In this case a metal of higher thermal expansion surrounds the ceramic of lower thermal expansion which, when soldered together, results in a strong vacuum-tight compression seal. The other type is the matched seal in which the thermal expansion of metal and ceramic is approximately the same. Glass-to-Kovar is a glass-to-metal seal of this type. The iron-nickel series of alloys covers a wide range of thermal expansion and a thermal-expansion match can be found for most ceramics; however, only over a limited temperature range.

Invar is a low-expanding material at relatively low temperatures but tends to increase quite rapidly as the temperature is increased. In the realm of ceramics, much lower thermal expansions are possible. In fact, there are two types which actually contract on heating. Both are lithium aluminosilicates. The one type exhibiting the low positive to low negative values (Fig. 4) is the crystalline phase beta-spodumene. It can be made to have no contraction or expansion up to 600 C. Beta-eucryptite is the other crystalline phase and its coefficient of linear thermal expansion is -5.6×10^{-6}. This latter material has not been made in the nonporous state and because of its very high degree of contraction,

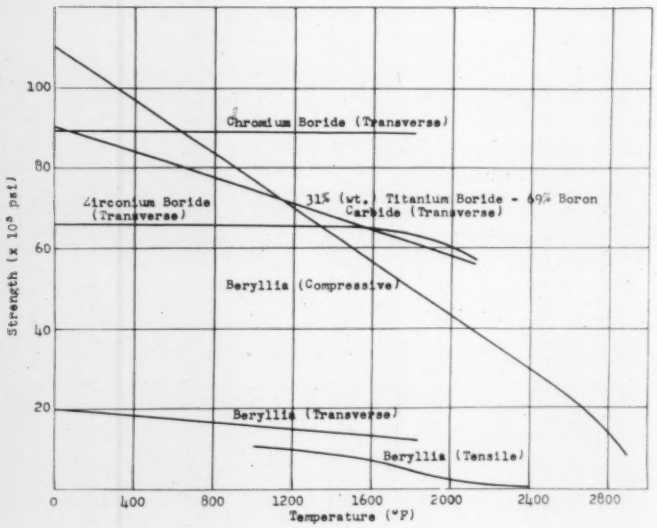

Fig. 6 Strength versus temperature curves of some ceramic materials

has found little use. However, the beta-spodumene is quite important as a refractory material (to 2200 F) of high thermal-shock resistance. Some uses include trays on which dental products are rapidly fired; tubes through which billets are heated to forging temperature by induction heating; and in the firing of certain white wares. It is being used as either zero or low-expanding tubes in dilatometers for determining thermal expansion of ceramics and metals at higher temperatures. It is being evaluated as a base material for precision electrical resistors and capacitors where dimensional variation with temperature is detrimental.

Thermal-shock resistance is relatively high in most porous ceramics because of inherent structure. However, where strong ceramics are desired porosity must be minimized. In dense ceramics the thermal-shock resistance is dependent to a marked degree on thermal expansion; the lower the thermal expansion the higher the thermal-shock resistance. Similar specimens of an alumina ceramic whose coefficient of linear thermal expansion is 8.0, crack when quenched into water at room temperature from 400 F. Beta-spodumene bodies, whose thermal expansion approaches zero, have resisted failure when quenched from 2200 F to water at room temperature.

Thus ceramic products cover the coefficient of linear thermal-expansion range from $+12.8$ to -5.6×10^{-6} in/in/deg C from 25–700 C, and ceramic products are being produced or can be designed to any specific value in this range.

Strength

The compressive strength of ceramic materials covers a very wide range from materials so weak that they can be crushed between the fingers in the case of some heat insulators, to values as high as 600,000 psi for a mixture of 31 per cent (by weight) titanium boride and 69 per cent boron carbide. In general, for more or less conventional ceramics, with tensile strength at unity, the transverse strength is approximately 2 times and the compressive strength varies from 8 to 10 times the tensile strength. One commercial alumina body has a tensile strength of 27,000 psi, its transverse strength is 50,000 psi, while its compressive strength is 290,000 psi. Alumina bodies with compressive strengths as high as 400,000 psi have been reported.

The values given in Fig. 5 are optimum values and these tend to decrease either with a decrease in the basic crystalline phase or with increase in pore volume. As an illustration, alumina ceramics are manufactured as special refractories with compressive strengths of the order of 11,000 psi while that of the completely nonporous material used as wear-resistant parts and electrical insulation has a compressive strength of 290,000 psi. This extremely strong material is being used as extrusion and pressing die parts, precision gages, plungers for reciprocating pumps, mechanical-seal parts, bearing sleeves, liners for pumps and impeller-wear parts, thread guides, and as high-frequency insulation particularly for vacuum-tight ceramic-to-metal seals.

Beryllia is another extremely strong ceramic with a compressive strength of 188,000 psi and transverse strength of 35,000 psi. Steatite, forsterite, and zircon ceramics have compressive-strength values between 75,000 and 90,000 psi. Steatite is the most economical of the group to manufacture. It is used extensively as electrical insulation especially for high-frequency applications and at moderately elevated temperatures because of its high strength, excellent electrical insulating properties, and the ability to fabricate this material to close dimensional tolerance. Porcelain, glass-bonded mica, and cordierite have lower compressive strengths in the range of 35,000 to 50,000 psi. Porcelain, because of its strength, ease of manufacture, and general durability, is used extensively for domestic and technical ceramics.

Fig. 6 shows the effect of temperature on the strength of some ceramic materials. A beryllia ceramic, whose tensile strength is approximately 14,000 psi at room temperature, is still 5000 psi at 1800 F; its transverse strength at room temperature is 20,000 psi and still 11,500 psi at 1800 F; while its compressive strength at the lower temperature is 110,000 psi, 50,000 psi at 1800 F, and 7000 psi at 2912 F. Chromium boride, whose room-temperature transverse strength is 88,000 psi, remains constant to 1700 F. Zirconium boride exhibits the same effect over the same temperature range with a value of 66,000 psi, and at 2200 F this value only drops to 55,000 psi.

The titanium boride-boron carbide material mentioned previously has a transverse strength of 90,000 psi at room temperature and drops steadily to 55,000 psi at 2200 F. It is these high-strength properties at high temperatures that are of extreme interest for high-temperature engines and air frames. Radomes which house radar equipment are being made of ceramic materials because of these properties. One laboratory is experimenting with actual missiles made entirely of ceramic materials, the reason being that as the speed increases, the temperature also increases and it appears that only ceramic materials can withstand the extreme conditions of temperature and pressure encountered.

CERMETS . . .

. . . *for High-Temperature Service*

Ceramics combined with metals to meet the critical demands of nuclear reactors, turbojets, gas turbines, and rocket motors

By J. T. Norton

Professor of Metallurgy
Massachusetts Institute of Technology, Cambridge, Mass.

CERMETS, which are aggregate structures of hard and refractory substances bonded with metal, have been extensively studied in recent years and a tremendous variety of substances have been examined. Compositions based on titanium carbide have so far given the best practical performance and will be considered here as a sort of yardstick by which the other cermet compositions of current interest may be compared.

Titanium Carbide

Titanium carbide, with the chemical formula TiC, is a hard and refractory crystalline substance with a melting point of 3250 C (5880 F). It has a bright gray metallic appearance and is a good electrical conductor.

It is made in commercial quantities by carburizing purified titanium dioxide. There is still considerable question as to what makes a good titanium-carbide powder for cermet manufacture. In general, one can say that it should have a combined carbon content approaching very closely its chemical formula and should have a minimum of oxygen, nitrogen, and free graphite.

Fabrication of Parts. The purified titanium-carbide powder is mixed with the desired proportion of the binder metal, also in powder form, and the mixture is ground and intimately mixed in a ball mill for periods of 2 to 4 days. Control of the carbide-particle size and size distribution is important. After grinding, the powder is carefully dried, a small amount of lubricant is added, and the powder is pressed. If the parts are relatively simple in form and are to be made in sufficient quantity to justify die costs, they may be pressed in a die to final shape, due allowance being made for shrinkage in the final sintering operation. Otherwise, blanks may be pressed and then given a preliminary sintering operation. In this condition, the compacts are sufficiently strong to handle but may be machined easily to the final shape. In either case the final operation is a sintering treatment in vacuum at a temperature usually just above the melting point of the binder metal. If final finishing is required, it is done by grinding, usually with diamond wheels. An excellent surface finish can be obtained.

The structure of the finally sintered body is one of carbide particles embedded in a matrix of the binder metal.

Contributed by the Metals Engineering Division and presented at a joint session of the Metals Engineering and Rubber and Plastics Divisions at the Diamond Jubilee Annual Meeting, Chicago, Ill., November 13–18, 1955, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Condensed from ASME Paper No. 55—A-196.

Fig. 1 Microstructure of a metal-bonded titanium-carbide cermet containing 50 per cent by weight of binder metal. Original magnification = 1500×. Gray rounded particles are the carbide and lighter background is the binder metal.

Fig. 1 shows the microstructure of a typical metal-bonded titanium carbide containing 50 per cent by weight of binder metal.

Several important variations of the conventional procedure are possible. The bodies may be hydrostatically pressed for better density distribution. They may be hot-pressed, a procedure which combines pressing and sintering in a single operation. They may be extruded into tube or rod form, or the binder metal may be introduced during sintering by the process of infiltration. Particular circumstances will determine the most practical technique.

Properties of TiC Cermets. The designer, of course, is primarily interested in the properties to be expected of these cermets. To illustrate typical properties three grades of metal-bonded titanium carbide have been selected for discussion. They were prepared under identical conditions with the binder metal which is an alloy of nickel-cobalt-chromium in the proportions of 3 parts nickel, 1 part cobalt, and 1 part chromium. Grade B40 contains 40 per cent by weight of the binder metal, C50 has 50 per cent, and D65 has 65 per cent. These grades are produced in Austria by Metallwerk Plansee under the general designation of WZ12. These grades were chosen for illustration because a consistent set of data was available and because they are typical of those now being produced both here and abroad.

In cermet development work, strengths are frequently measured by means of a transverse rupture test but the strength values are somewhat dependent upon the test

conditions. Tensile tests, on the other hand, are more significant for purposes of design, but it is very time-consuming and expensive to prepare accurate tensile specimens and to provide testing conditions of very precise axial loading. Fortunately, for the grades to be considered, both sets of data are available and Fig. 2 shows how they are related at room temperature. It will be seen that the bend-strength values (modulus of rupture) are higher by a factor varying from about 2.0 at low binder content to about 1.7 at the high binder content.

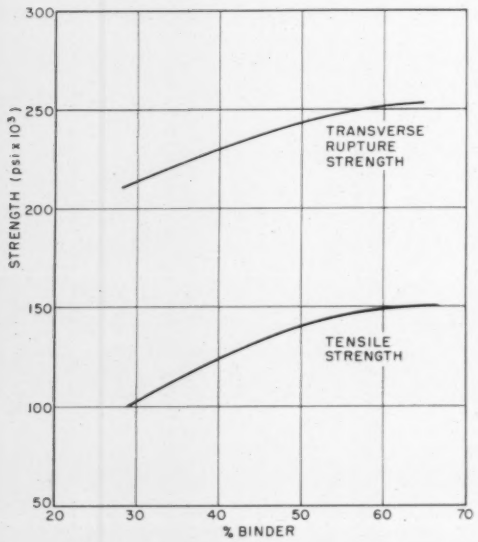

Fig. 2 Curves showing dependence of transverse rupture strength and tensile strength on binder content in TiC cermets at room temperature

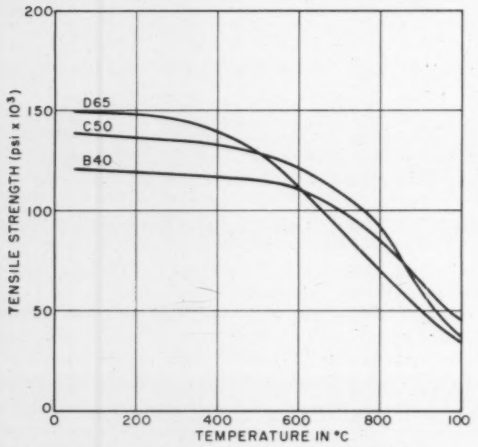

Fig. 3 Curves showing dependence of tensile strength upon temperature of TiC cermets with different binder content

It is of interest to note that the strength increases with increasing binder content over the range investigated. The curves appear to approach a maximum and undoubtedly would fall at still higher binder content. This may seem strange in view of the hardness values which decrease with increasing binder content, the values for grade B40 being 960 DPH; C50 being 820 DPH; and D65 being 600 DPH. This behavior, however, appears to be characteristic of these rather brittle materials. The impact strength, on the other hand, increases markedly with binder content, the values, as measured by a Charpy test on an unnotched bar of 1 sq cm cross section for grades B40, C50, and D65 being 45, 70, and 106 in-lb, respectively. Thus as the binder content of the cermet increases, the strength and toughness increase while the indentation hardness decreases.

The influence of temperature on the tensile strength is revealed in Fig. 3 where the results of short-time tensile tests are shown. It will be observed that grade D65, which is the strongest at room temperature, loses its strength more rapidly and at 1000 C (1830 F) it has become the weakest, the order of strengths being just reversed as compared with room temperatures.

Long-Time Strength. The long-time strength at elevated temperatures is, in many respects, a much more useful index of the suitability of these materials. This test gives the stress at which the material will fracture in tension after a definite period of time at a specific temperature. This strength decreases with increasing time and the decrease, as would be expected, is more rapid at higher temperatures. Fig. 4 shows the behavior of grade C50 at 800 and 1000 C (1470 and 1830 F). For general purposes of comparison, the strength for 100-hr life is a convenient figure.

Curves of 100-Hour Life. Fig. 5 shows the curves of the 100-hr life for the three grades considered in the temperature range from 800 to 1000 C (1470 to 1830 F). The strength decreases with increasing temperature and grade B40 with the lowest binder content is the strongest of the three while grade D65 is the weakest. If one arbitrarily selects the operating temperature of 950 C (1740 F), these tests show permissible strength levels of approximately 25,000, 19,000, and 15,000 psi for grades B40, C50, and D65, respectively, for 100 hr lifetime. Thus the short-time strength is higher by a factor of between 2 and 3 than the 100-hr strength. In the same figure are shown corresponding typical values for two of the so-called "super alloys." At any particular temperature within this range, the TiC cermets provide a significant increase in strength over the conventional high-temperature alloys.

Boride-Base Cermets

The borides of the transition metals are hard and refractory substances and have been studied extensively as components for cermets. The two borides of particular interest are those of zirconium and chromium which are being developed under the commercial designation of "Borolites." The particular feature of the zirconium-boride cermets is the fact that while they are not as strong as the TiC cermets at room temperature, they retain a significant strength above 1100 C (2000 F). At this temperature the oxidation resistance is adequate for a life of at least 200 hr. The heat-shock resistance is sufficient to pass the NACA test but the resistance to mechanical shock is disappointing.

Chromium-boride compositions have the same ability

to retain strength at high temperature and have somewhat better oxidation, mechanical, and heat-shock resistance than the zirconium-boride grades. Chromium-boride has excellent resistance to chemical attack. The boride cermets have shown very good results in applications involving rather short-time cycles at very high temperatures.

Oxide-Base Cermets

Probably the first cermets investigated were those based on the metallic oxides such as BeO, Al_2O_3, Cr_2O_3, MgO, SiO_2 with various metallic binders. The group using alumina bonded with chromium or chromium-base alloys has shown the greatest promise. A composition containing about 70 per cent by weight of chromium (about 50 per cent by volume) has been made commercially under the name Haynes Metal Ceramic LT-1 and has found application as crucibles, thermocouple protection tubes, and radiant-heater tubes. It has excellent oxidation resistance up to 1200 C (2200 F) and is reasonably resistant to heat shock but its tensile strength is only about one half of that of the TiC cermets at room temperature and at 1000 C (1830 F).

Similar compositions with a chromium-binder content of 30 per cent by weight also have been studied and show improved strength and creep-rupture properties in the 1000–1200 C (1930–2200 F) range where TiC-base materials are not usable. The compositions suffer, however, in thermal and mechanical shock resistance as the binder content is lowered. This group of alloys is receiving much attention at present and undoubtedly improved properties already have been obtained in the laboratory.

Intermetallics. Cermets based on other refractory substances have been studied and the principal ones are the strong and high-melting intermetallic compounds such as the aluminides, silicides, titanides, and the like. Compositions based on nickel aluminide (NiAl) have considerable merit. Its oxidation resistance is superior to the TiC-base composition at the higher temperatures, its stress-rupture properties are comparable, and its impact resistance is also of the same order, which is far ahead of the other noncarbide cermets. This composition also has shown unusual resistance to attack by molten glass.

Molybdenum disilicide ($MoSi_2$) also has a very high oxidation resistance but has not as yet shown sufficient strength for general application. Its electrical properties have led to its consideration as a high-temperature heating element. A number of the titanides, of which chromium titanide (Cr_2Ti) is an example, have shown very good stress-rupture properties at temperatures considerably above the limits of the TiC base materials but as presently prepared they are all too brittle for practical consideration.

General Discussion

The present status in the cermet field, in so far as structural parts for high temperatures are concerned, may be stated somewhat as follows: In the temperature range of 1600–1650 F alloys are available which are quite adequate in strength and toughness, namely, the conventional super alloys. In the 1750–1800 F range alloys with good strength properties and a toughness adequate for many applications are to be found in the metal-bonded titanium carbides. In the 1800 to 2200 F range, a number of cermet materials of adequate strength are being used in short-time application, and a few with adequate long-time strength. However, these are, without exception, too brittle to meet even the minimum specifications which a designer would set for many practical applications. Although this result is very disappointing it does not mean that the cermet program itself has been unsuccessful. In almost every case special and important properties of the cermets have been revealed which undoubtedly will find particular applications in which cermets will outperform any other competitive materials and these applications may well justify all of the effort and expense of the program.

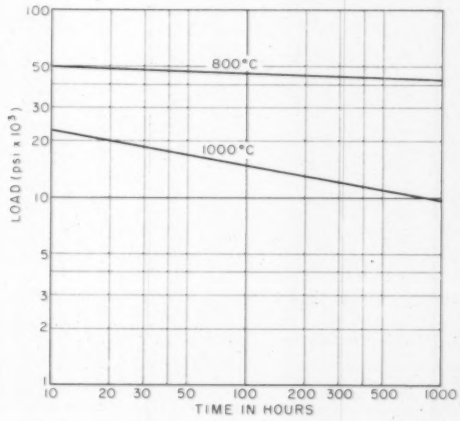

Fig. 4 Curves showing dependence of strength of TiC cermet with 50 per cent by weight of binder on time of loading at two different temperatures

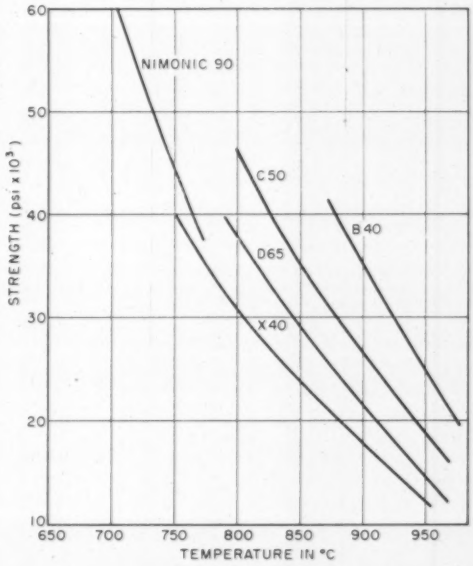

Fig. 5 Curves showing strength in 100-hr stress-rupture test at different temperatures for three TiC cermets and two super alloys

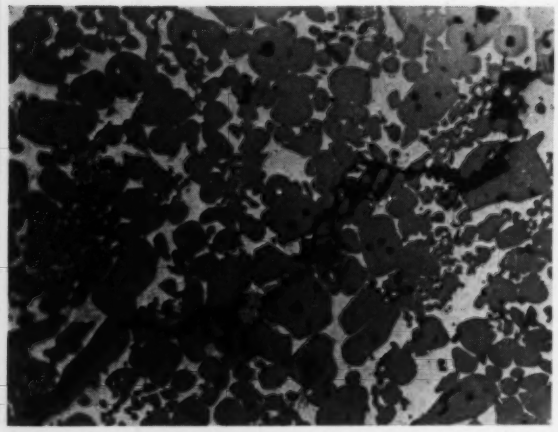

Fig. 6 Microstructure of a TiC cermet with approximately 40 per cent by weight of binder containing an artificially produced tension crack

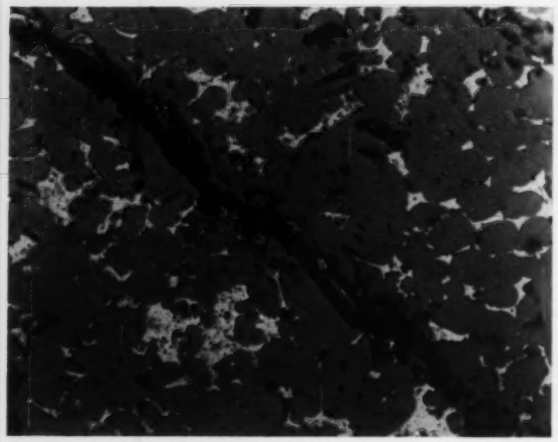

Fig. 7 Microstructure of a TiC cermet with 20 per cent by weight of binder containing an artificially produced tension crack, showing carbide grains in direct contact

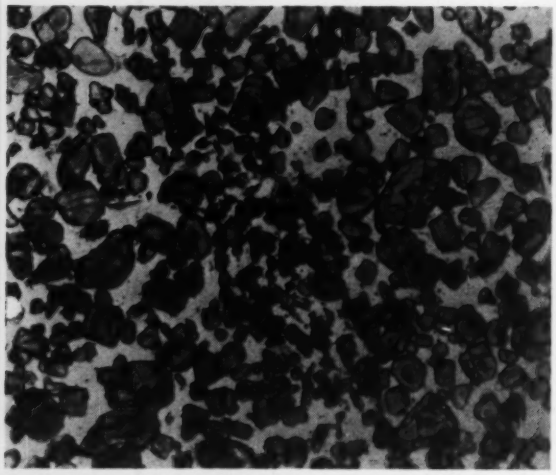

Fig. 8 Microstructure of a TiC cermet with 50 per cent by weight of binder containing an artificially produced tension crack, which is quite discontinuous

There are at least two aspects of the solution of the problem of high-temperature materials; namely, better materials and a better understanding of how to use them. The new materials will not behave like steel and one should not expect to substitute them directly in devices designed for steel. The designer and engineer must be intimately acquainted with their good and bad properties and be willing to approach the problem courageously and with an open mind. At the same time, the materials themselves must be improved. Unfortunately, there is at present no consistent theory for the mechanical properties of an aggregate structure such as a cermet, but the problem is being attacked on several fronts.

One particular direction is the study of the general dependence of strength and toughness on the microstructure, that is, the influence of the size and shape of the hard particles and the distribution of the metal binder phase as distinct from the bulk properties of the substances themselves. Another is a study of the mechanism of fracture. Figs. 6, 7, and 8 show artificially produced fractures in TiC cermets of different binder content. They show clearly the preference of the crack path for the carbide grains and indicate that the criterion for improved toughness requires that the carbide grains be separated by films of binder metal, thereby interrupting a continuous fracture path through the carbide.

Still another direction of study is the problem of obtaining the desired microstructure with the desired materials in actual production of parts. This is a very fundamental problem in liquid-phase sintering which is only beginning to be attacked in detail and there is evidence that very small changes can produce profound modification of structure. One can confidently expect substantial improvements in the properties of cermets as the result of these studies.

Molybdenum as a High-Temperature Material

One might ask whether there is any other material, not of the cermet type, which promises to be a serious competitor in the high-temperature field. There is such a material and it is molybdenum. Alloys of molybdenum are now in development which have high-temperature properties superior to any of the current cermets. The great barrier to their direct application is their lack of oxidation resistance. The use of this material is dependent upon the finding of a suitable method of applying an oxidation-resistant coating. This is not far distant and the cermets may possibly lose this important race to coated molybdenum. The difficulties of the coating problem, however, must not be underestimated. At high temperatures, molybdenum oxide is highly volatile which means that the coating must be completely continuous and free from cracks or even the smallest pinhole. Also, it must be stable for long periods at high temperature. It is not impossible that the successful coating may itself be a cermet.

Acknowledgment. The author wishes to express his thanks to the many people who have kindly contributed to the data on cermet development contained in this discussion. He would especially mention Dr. Richard Kieffer and Dr. K. Pfaffinger of Metallwerk Plansee, Reutte, Austria; Dr. Paul Schwarzkopf and his staff of American Electrometal Corporation, Yonkers, N. Y.; and Dr. Joseph Gurland, Brown University, Providence, R. I.

Fig. 1 Production vacuum-melting line; 90 and 300-lb vertical furnaces in foreground; 1000-lb horizontal furnace in rear

Vacuum-Melting Nickel-Base Alloys on a Production Scale

1000-lb-capacity furnaces produce 500-lb static ingots or 4-ft centrifugally cast rings

By F. N. Darmara[1] and J. S. Huntington[2]

Utica Drop Forge & Tool Corporation, Utica, N. Y.

VACUUM melting is not a new technique. In the 1930's Heraeus Vacuumschmelze, A. G. in Germany was melting heats of nickel-chromium resistance alloys weighing several tons. Unfortunately, the degree of vacuum was of the order of several millimeters of mercury which represented the ultimate pressure for large-size pumps then in existence.

Developing the Process

Small laboratory furnaces with capacities of less than 1 lb had been built, usually of all-glass construction, and with this equipment lower pressures were obtainable. Furnaces of this type were of considerable help in developing new alloy systems and for basic research; however, they did not lend themselves to production melting techniques.

During World War II the atomic-energy program required enormous vacuum installations for separation of uranium isotopes by gaseous diffusion, which resulted in the development of high-speed pumps operating in the 1 to 10-micron range (1 micron–$^1/_{1000}$ mm of Hg). These pumps enabled vacuum furnaces to be constructed soon after the war with capacities of 100 lb and operating pressures below 10 microns. As experience was gained larger units were built and today several furnaces with a capacity of over 1000 lb are in operation.

In 1951 the authors' company, a producer of gas-turbine forgings, became concerned with the inconsistencies of superalloys melted by conventional means. While some heats met the stress-rupture specifications with a comfortable margin, other heats fell far short of the minimum required rupture life. It was felt that vacuum melting might provide a means of obtaining metal with more uniform properties from heat to heat. The absence of slag and an oxidizing atmosphere

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would allow a much closer control of the chemistry of the melt. In particular, titanium and aluminum could be held within the close limits required for maximum high-temperature strength. In addition, much of the high chromium-nickel-cobalt-bearing scrap generated by off-specification heats and by processing could be used directly as a major charge constituent. This is not possible with the usual air-melting practice.

With the co-operation of the Air Materiel Command, two vacuum-melting furnaces with 90 and 300-lb capacities were procured. A small 6-lb furnace was designed and built while the larger furnaces were under construction, and with it much valuable operating experience was obtained. After the large furnaces were in operation and the vacuum-melted alloys had shown remarkable improvement in physical properties, two 1000-lb furnaces were obtained to increase production facilities.

Production Plant

The furnace line today is shown in Fig. 1. The 90 and 300-lb furnaces consist of vertical tanks containing the necessary induction-melting furnaces, additions-making devices, crucible covers, bridge breakers, and so on, all remotely controlled by levers and hand wheels from convenient stations outside the furnace shell.

Single ingots up to 150 lb can be poured in these furnaces. However, the majority of their output is in the form of small 13-lb ingots of which 23 are cast per heat in the 300-lb unit.

This smaller ingot is used primarily as a source of forging stock for the Turbine Parts Division. The ingots are of such a size that they can be fullered into bar stock and forged into turbine buckets without the need of rolling-mill conversion.

The 1000-lb furnaces are used to cast either static ingots weighing up to 500 lb each or centrifugally cast rings up to 4 ft diam. One of these furnaces is shown in Figs. 2 and 3.

Process Details

The melting chamber consists of a double-walled tank 8 $^1/_2$ ft diam and 9 ft long with one end closed and a sealing flange on the open end. This tank is mounted on a carriage which travels on rails across the width of the melt shop. In one wall of the melt shop is mounted the cover piece through the center of which protrudes the 10-in. shaft of the centrifugal-casting machine. The tank can be rolled forward to meet the cover and thereby seal off its contents for evacuation.

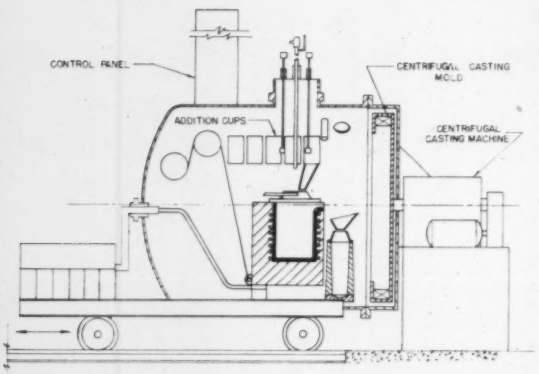

Fig. 2 Sketch of cross section of 1000-lb furnace in closed position

The tank is evacuated by two groups of three diffusion pumps mounted on the carriage on either side of the tank. Each group of pumps is backed by a 500-cfm mechanical pump which is connected when the furnace is in the closed position. The pumping speed at 10 microns is 20,000 cfm.

In addition, two smaller mechanical pumps attached to the furnace carriage keep the diffusion pumps under vacuum when the furnace is open and evacuate the lock system.

A 3000-cycle 300-kw generator supplies induction power to the furnace coil, and capacitors for power-factor correction are mounted on the carriage close to the power inlet to the tank.

The crucible is poured by an external variable-speed motor operating a drum-and-cable system.

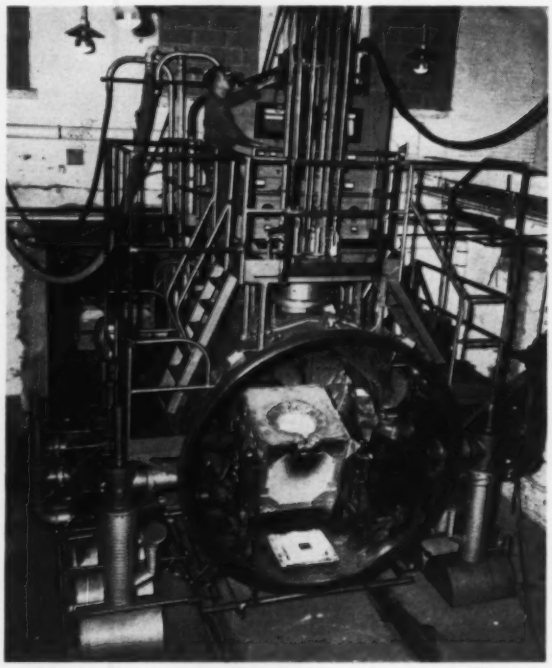

Fig. 3 1000-lb furnace in open position showing crucible and control deck

There are six addition buckets inside the tank capable of holding several hundred pounds of metal. These can be dumped in any sequence into a vibrating chute which carries the metal at a controlled rate into the crucible.

Through the "top hat" directly above the melt, samples can be withdrawn through vacuum locks. Temperatures also are measured from this location by immersion thermocouples.

Molds for static casting are located directly in front of the melting furnace and are filled through an appropriate tundish. Centrifugal castings are made by replacing

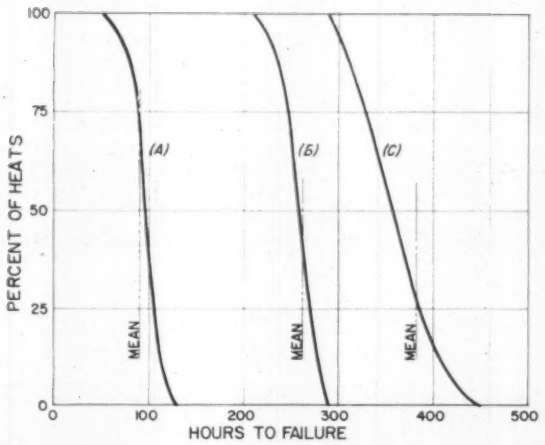

Fig. 4 Stress-rupture results for production Waspaloy heats at 1500 F, 32,500 psi. Curve A, results of 100 air-melted heats; curve B, results of 100 vacuum-melted heats, early melt practice; curve C, results of 40 vacuum-melted heats, latest practice

the tundish with a runner pot which diverts the molten metal into the spinning mold.

The large single ingots are converted to bar stock by conventional rolling-mill practice; however, the centrifugally cast rings can be utilized in several ways and offer specific advantages over static castings for certain applications. This ring can either be cut up into wedge-shaped pieces for direct forging into finished parts, or if bar stock is required, longer segments can be rolled without the need of cogging or heavy break-down equipment. The as-cast grain size is extremely fine and uniform which promotes better forgeability. (A 1000-lb ring may be cast with an OD of 48 in., an axial length of 9, in. and a wall thickness of $2^1/_2$ in.)

Operating Problems

Several metals such as manganese, chromium, and aluminum have a vapor pressure in the molten state which is greater than the surrounding vacuum; consequently these elements boil off to some extent during the melt. While their loss is made up by adjustment of the initial-charge weight based on experience, the evaporated metal is a considerable nuisance since it condenses on cooler portions of the tank as a finely divided powder or contaminates the vacuum-pump oil. Screens are somewhat effective in preventing the oil contamination, but they impede the gas flow considerably. The dust on the tank walls must be cleaned frequently since it is pyrophoric, unsightly, and a general health hazard.

To produce quality metal in 1000-lb heats, the same degree of control must be exercised as in laboratory melts of a few hundred grams. A major problem arises in finding operators to handle a production process who will exercise the same care as the research worker. We have solved this problem by training our personnel carefully in all phases of the work and conducting regular classes in which the basic principles of the equipment and processes are presented in an orderly program. The men are made to feel a part of the operation by keeping them up to date on all new developments so they will realize the importance of every required operation, no matter how trivial it might seem.

Initial Experience

Utica's first experience was with Waspaloy, an alloy having the composition given in Table 1.

Table 1 Composition of Waspoloy

	Per cent		Per cent
Chromium	18.00–21.00	Carbon	0.10 max
Cobalt	12.00–15.00	Manganese	1.00 max
Molybdenum	3.50– 5.00	Silicon	0.75 max
Titanium	2.75– 3.25	Sulphur	0.03 max
Aluminum	1.00– 1.50	Nickel	Remainder
Iron	2.00 max		

This alloy was forged into turbine blades which had to meet a stress-rupture specification of greater than 40-hr life at 1500 F under a stress of 32,500 psi. It was difficult to obtain air-melted heats which would consistently meet this requirement. Some would last 100 hr on test, but many failed in as few as 20 hr. By taking bars from heats with poor properties and remelting them in vacuum with minor additions to attain optimum chemical analysis, we were able to increase the life to rupture by as much as 500 per cent. As we got into the production melting of Waspaloy, and developed better melting technique, the alloy was steadily improved to the point where average life ran approximately 250 hr, with a minimum of 210 and a maximum of 290.

Curves A and B in Fig. 4 compare the spread of vacuum-melted Waspaloy heats with a similar number of heats made by the best air-melting practice. It can be seen that there is a threefold improvement in the life to rupture.

To cut down our testing time on this alloy we were forced to increase the stress in steps of 2500 psi, and we now are testing at 40,000 psi. To date we have melted over 300,000 lb of Waspaloy and a survey of 52 recent consecutive heats shows an average life of 86 hr with a range of 70 to 111 hr at 40,000 psi and 1500 F. The elongation averages 18 per cent.

Results Achieved

In order to compare these data at 40,000 psi with the earlier results we have multiplied the life of each heat by a factor of 5.2 to indicate the expected life at 32,500 psi. The results are shown as curve C in Fig. 4, and indicate a further improvement in the properties of the alloy. The factor of 5.2 was obtained by running stress-rupture tests at 1500 F on several heats of Waspaloy at a variety of stresses to obtain the slope of the stress versus life curve.

The ability to hold the aluminum and titanium contents within close limits is demonstrated in Figs. 5 and 6 for twenty consecutive heats. It can be seen that the maximum deviation from the aim is 13 per cent for aluminum and 9 per cent for titanium, including the errors in spectrographic analysis.

Similar results have been obtained by melting other nickel-base alloys, such as M-252, and in every case a decided improvement in stress-rupture life and ductility has been noted when groups of vacuum-melted and air-melted heats have been compared.

Castings and Alloy Systems Improved

While the foregoing results were obtained with wrought material, it has recently been shown that vacuum melt-

ing improves the high-temperature properties of cast alloys also. When investment castings are made by usual protective atmospheric melting using a charge of vacuum-melted master alloys, the rupture life is found to be about twice that of castings made with air-melted master alloys. Investment castings made directly in vacuum have shown even greater improvements in life; however, this technique is still in the experimental stages.

Unfortunately, vacuum melters have not had an opportunity to investigate many alloy systems as yet, and have concentrated on those which showed most initial improvement. While our experiences have centered on the development of materials with higher strength at elevated temperatures, other companies with production vacuum-melting facilities have shown that certain properties in alloys of different types also can be improved.

After considering the improvements shown in certain alloys by vacuum melting, the materials engineer will ask, "How will my alloys be benefited by this process?" To answer this question we must consider just what takes place when metal is melted under a pressure of 0.00001 atm. If we take, for example, a typical high-temperature alloy such as Waspaloy and examine the way in which vacuum melting helps to improve its properties, we can get a clearer picture of the phenomena taking place.

Vacuum-Melting Techniques

The high-temperature strength of Waspaloy depends on a closely controlled ratio of titanium and aluminum as precipitation-hardening elements. In order to obtain the maximum stress-rupture strength the amounts of each of these metals should be controlled to a range not wider than ±0.1 per cent. Since both aluminum and titanium are extremely reactive, a major problem in air melting exists in trying to get these elements into the alloy without losing a considerable percentage as oxides or nitrides. These may be formed by reaction with dissolved gases or oxides in the melt, or during the pour. In addition to changing the composition, the oxides and nitrides produce stringers and dirty material.

Another detriment to high-temperature strength in these alloys is the presence of minute quantities of lead, magnesium, and other impurities such as dissolved gases which affect not only strength but also forgeability. Elaborate oxidation, deoxidation, and desulphurization techniques must be resorted to in air melting and even at best the dissolved gases are difficult to reduce below several hundred parts per million.

When such an alloy is melted in vacuum, the basic charge of nickel-chromium-cobalt and molybdenum is loaded into a crucible carefully selected to be as inert as possible to the alloy constituents. The pressure in the vacuum tank surrounding this crucible is reduced to below 10 microns (0.00001 atm). As the charge is melted at this low pressure, the gases, which were dissolved in the as-received material, are boiled off and pumped away. In addition, several reactions can be employed to further remove unwanted components. By adding controlled amounts of metal oxides, the sulphur content of nickel alloys can be reduced by the formation and removal of sulphur dioxide. Several of

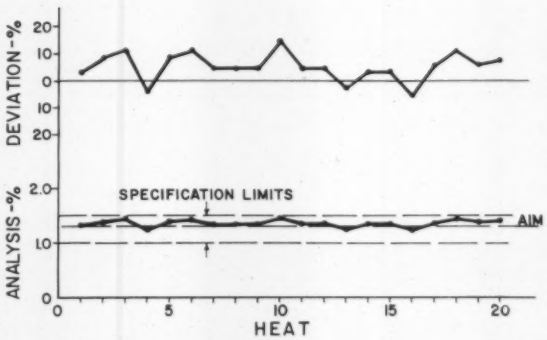

Fig. 5 Aluminum analysis and deviation from the aim for 20 vacuum-melted heats

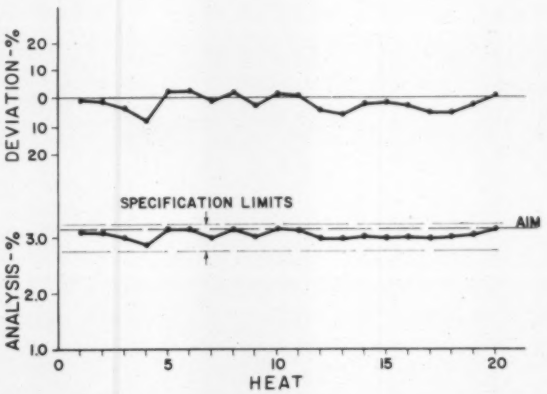

Fig. 6 Titanium analysis and deviation from the aim for 20 vacuum-melted heats

the oxides present in the incoming material can be reduced by controlled carbon or hydrogen additions which form carbon monoxide or water vapor and are pumped away. Impurities such as magnesium, lead, and other volatile elements are removed automatically because of their high vapor pressure at the temperature of the melt. It is only after these purifying treatments have been completed that titanium and aluminum are added.

By withdrawing samples of the melt through a vacuum lock, and using a direct-reading spectrometer, it is possible to obtain a complete analysis of the melt prior to pouring and any variation from the required composition is easily corrected with additions through vacuum locks.

The melt is then poured into molds with no danger of gas-metal reactions changing the compositions or producing dirt in the form of oxides or nitrides. The absence of dissolved gases also produces a sound ingot free from blowholes or porosity.

Vacuum melting therefore can produce a cleaner metal with a more closely controlled chemistry. The cleanliness is brought about by removal of dissolved gases, reduction of oxides, nitrides, and sulphides, and the evaporation of volatile impurities. The composition is controlled by eliminating the possibility of losses of critical elements by reaction with gases.

Nodular Iron in Switchgear

Improved production and lower costs for this new ferrous casting material assure wider application in fast-growing switchgear industry

By F. E. Florschutz

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An industry, growing as rapidly as that of electrical switchgear, is always on the lookout for new promising materials. Early switches and circuit breakers, designed around the turn of the century, used gray iron where ferrous castings were called for. As the equipment grew both in size and importance the shock conditions, inherent in the operation of circuit breakers, required materials with high ductility and strength. Malleable iron for the smaller and more intricate parts and cast steel for the larger parts filled the demand quite well for some decades. Since the advent of welding in the twenties, many a weldment has competed successfully with cast construction.

In the past few years, however, a newcomer, nodular iron, with its combination of attractive properties, has largely superseded the other casting materials on switchgear applications. Its tensile strength, yield strength, and elongation compare well with cast steel and malleable iron. It has definite advantages over cast steel in castability of detail, machinability, appearance, and cost. Nodular iron, because it is chemically similar to gray iron with the addition of a small amount of magnesium, can be produced readily in a cast-iron foundry. Table 1 shows comparative figures of the three casting materials.

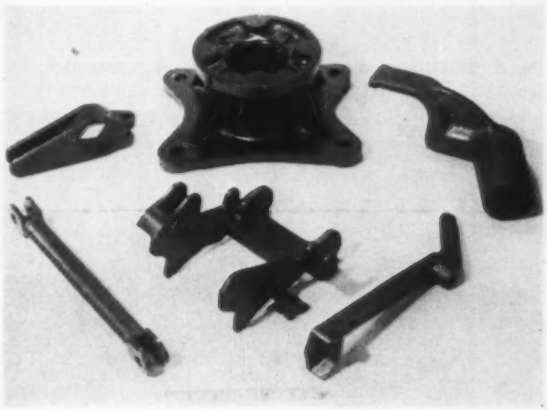

Fig. 1 Some typical nodular-iron castings for switchgear

Table 1 Comparative Properties of Three Casting Materials

Material	Tensile strength, psi	Yield strength, psi	Per cent elong.	Machinability, CRS 100 per cent	Castability	Cost	Delivery
Malleable iron	53000	35000	18	150	Good	Fair	Long
Cast steel	70000	36000	22	75	Fair	High	Medium
Nodular iron	60000	45000	15	150	Good	Low	Short

Nodular iron, like any other material, can be misapplied. Only knowledge, experience, and alertness will protect against it.

A distinct shortcoming of this otherwise exceptional engineering material is the lack of a good welding method. Although sound welds can be produced, the weld heat-affected zone is very hard and brittle. This condition requires caution in the use of welding nodular-iron parts, subject to high stress, particularly with shock loadings.

The higher the strength of a casting material the more important is the reliability of the final casting. However, porosity and blowholes will always be with us, although not specified on drawings. The casting designer who knows what causes these weaknesses can contribute most in avoiding them. With good designs established, the nodular-iron foundry must use the best casting techniques available and must have accurate control of all its manufacturing operations, including the annealing process.

Contributed by the Metals Engineering Division and presented at the Diamond Jubilee Annual Meeting, Chicago, Ill., November 13–18, 1955, of The American Society of Mechanical Engineers. Condensed from ASME Paper No. 55—A-150.

Nodular Iron on New Designs

Since 1951 all new designs that previously would have used malleable iron or cast steel and even some weldments have been channeled into nodular iron.

Replacement of Cast Steel and Malleable Iron. Fig. 1 shows a variety of such castings. These include a lever, a link, a pedestal, and a socket. All are parts of operating mechanisms and lever systems of circuit breakers and disconnect switches. Other typical active applications in switchgear are insulator caps and flanges, latches, bearings, housings, covers, brackets, handles, bell cranks, bases, crossbars, etc.

Replacement of Weldments. For many years there has been a continuous "tug of war" between foundries and

Fig. 2 Nodular-iron rod end for operating mechanism

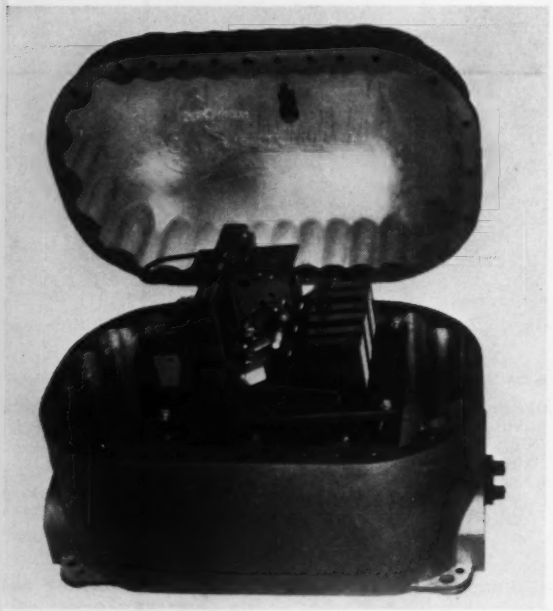

Fig. 3 600-volt air circuit breaker in explosionproof box of ductile iron

fabricators concerning which of the two methods has the economic advantage. Many advertisements have shown that both sides can claim cost reduction by changeover. Nodular iron, with its high strength, good ductility, castability of intricate detail, and large permissible size of parts, opens to the foundries a new field in this competitive struggle.

There are some particularly interesting applications of nodular iron in switchgear that require special attention.

Rod End. The casting shown in Fig. 2 carries a load of 20,000 lb, starting at standstill and reaching a speed of 8 fps at the end of a $5\frac{1}{2}$-in. stroke when it is brought to a sudden stop. It is part of the linkage of a pneumatic mechanism used to operate high-voltage circuit breakers. Owing to the importance of absolute reliability in this application, it was decided to set up independent special quality-control tests. Originally, each part was checked by:

1 Visual inspection.
2 Brinell hardness checking.
3 X-ray examination.
4 Metallographic examination.

The latter was done by drilling a $\frac{1}{4}$-in-diam cylinder out of each rod end and with 100 magnification inspecting this cylinder for:

(*a*) Per cent of flake graphite.
(*b*) Per cent of pearlite.
(*c*) Per cent of free cementite.

After gaining some experience, this inspection was reduced to Steps 1 and 4, namely, visual and metallographic examination. These independent inspections have shown the need of much better quality-control methods at the foundry than were necessary in gray cast-iron production at the same foundry.

Pressure-Tight Castings. With increasing demand for ferrous pressure-tight castings on circuit breakers using dry compressed gas for circuit interruptions, a new field is opening up for nodular iron in switchgear applications. The spheroidal form of the graphite in the casting minimizes leakage and makes this material very attractive for this application. Several parts are now in use in the development stage of new designs.

Explosionproof Enclosures. Contactors and circuit breakers stationed in oil fields, refineries, mines, and other places where explosive atmospheres exist have in the past been enclosed in thick-walled cast-iron boxes. Within the past few years all these designs have been changed to use nodular iron at about one half the previous wall thickness. Fig. 3 shows such an enclosure, measuring $48 \times 34 \times 32$ in. and weighing 1600 lb for the housing and 600 lb for the cover. Its minimum wall thickness is $\frac{1}{2}$ in. These enclosures are tested at 350 psi water pressure for 1 min.

Shell-Molded Nodular Iron. This relatively new casting method is used where machining required for sand castings can be eliminated because of the closer casting tolerance and better surface quality obtained by this process. It encourages designs that would be very difficult or even impossible to machine.

Changeover of Existing Designs From Other Cast Materials

Even in cases where it means changes to existing pattern equipment, it may be of advantage to consider nodular iron. Therefore it seemed desirable to study all active malleable-iron and cast-steel parts for possible changeover. A total of 483 existing patterns was included in this study. It was found after some experimenting that the cost of the pattern changes involved because of the necessary change in gating, and in a few cases because of the different shrinkage rate, amounted to about 20 per cent of the cost of new patterns. Some of the patterns were for castings that had too low an annual activity to justify the expense of a changeover. Others, although highly active at the time, were known to become obsolete soon, as a result of new superseding designs. This elimination work led to a changeover of 30 patterns from malleable iron to nodular iron and 11 patterns from cast steel to nodular iron. The average saving on the first group was 37 per cent and the average saving on the second group 45 per cent on the foundry cost, plus 24 per cent more due to the easier machining of the new material.

Steel's Role in Nuclear Engineering

Nuclear developments create new uses for steel and find applications in steelmaking processes

By C. L. Huston, Jr.

Lukens Steel Company, Coatesville, Pa.

Those who are trained and experienced in the engineering and scientific professions and who serve either in steel-producing or steel-consuming industries will be counted upon to develop practical answers to progressively new problems as they arise in the application of steels to the broader employment of nuclear fuels.

It may be said that broad industrial participation in atomic research and development for commercial purposes began in 1954 when the Federal Government by legislative action removed many of the wartime restrictions on nuclear technology. Since then, the Atomic Energy Commission has been releasing information and admitting industry as part of the team. As a result, much of the early mystery and conjecture has been removed. We have learned that no hocus-pocus but instead, orderly processes produce power with atomic fuels. At the same time it has become increasingly evident that steel in its various types and with its many characteristics and qualities has played and will continue to play an important role in the successful development of nuclear engineering.

Conventional Uses

In an atomic reactor itself steel finds its major use as structural material to support and contain the reactor components. The buildings that house the reactors are also often constructed of structural steel. Steel is being designed and applied as a complete shell around some reactors to restrain radioactive leakage in the event of an accidental failure.

An interesting example of steel usage is at Battelle Memorial Institute's hot-cell laboratory. The protective walls of the cell are faced on both sides with $^1/_2$-in. steel plate and the access doors are slabs of steel up to 18 in. thick, weighing as much as 20 tons.

Stainless Steels in Reactor. While ordinary carbon steels are not used widely in the reactor core at present, steels of the stainless types are being incorporated. Stainless steel fills such applications as cooling fluid pipes, core shells, and heat exchangers. Stainless-clad steels also are being applied extensively in atomic power reactors. One such application is the use of heavy-gage stainless clad to fabricate a vessel 9 ft in diameter × 25 ft high to house the reactor core of the Duquesne Light Company's Shippingport, Pa., reactor.

Steel also plays an important part in the manufacture of machinery related to atomic reactors. Gears, bearings, control rods, springs, instruments, valves, pumps, and other operating mechanisms are made largely of this basic metal. The air of the reactor room is cleaned and purified by equipment made of steel. The elevators that traverse the reactor faces are of all steel construction as are the catwalks and railings of the access system. In fact, in almost all of the auxiliary equipment associated with the reactor, steel plays an important role.

When the heat from an atomic reactor is used to generate electricity, steel again becomes a vital factor. The piping, turbine frames, generator parts, and related equipment all have steel in them. The power-transmission systems depend on substantial quantities of structural steel.

There is an additional use of the subject metal. Some of the waste products of the fission process remain dangerously "hot" for 35 years or more; so at present they are concentrated and stored in stainless-steel tanks sunk in the ground.

Ship Propulsion

As nuclear fuels are engineered in fields other than electric power, we note promptly their introduction into the interesting area of nuclear propulsion. Here, too, steel follows along as illustrated by the construction of the atomic submarines *Nautilus* and *Seawolf*. From conning towers to the innermost parts these underseas ships make extensive use of it. Before long nuclear fuels undoubtedly will be found in surface vessels, as indicated in a recent presidential announcement. Although Congress turned down the immediate proposal for an atomic-powered peace ship, federal funds are to be earmarked for the construction of a tanker to be propelled by nuclear energy. An atomic-powered locomotive has been built experimentally and is being tested.

While it is difficult to estimate the total quantities of steel to be used in future applications of atomic-energy fuels in comparison with the quantities consumed by static and dynamic power units and systems today, it reasonably can be assumed that research and design engineers will find increasing rather than reduced markets for such a basic, economic, and versatile metal as steel.

Radioisotopes in Steelmaking

As Mr. Charles M. Parker, assistant vice-president of The American Iron and Steel Institute, who is an eminent metallurgical engineer, pointed out in a recent talk, member companies of the industry are busily studying the possible benefits of atomic energy to the industry and are

Presented at the Nuclear Engineering Luncheon at the Diamond Jubilee Annual Meeting, Chicago, Ill., November 13–18, 1955, of The American Society of Mechanical Engineers. Slightly condensed.

preparing to aid the over-all development through their products and services. For example, radioisotopes which are created as a by-product of atomic reactors or by other means, are proving to be uniquely useful not only in research but also in specific applications such as automatic gaging in the continuous sheet-and-strip process. He referred to other applications in which radioisotopes are helping to determine the relative percentages of organic and inorganic sulphur in coking coal. He also stated they are aiding the study of reactions within blast furnaces for improved control of sulphur in the production of molten pig iron.

Referring to the area of steel research and the effects of bombarding metals with high-velocity atomic particles, Mr. Parker reported that recent experiments on carbon and stainless steels produced changes in their structures which cannot be duplicated by alloying, heat-treatment, or rolling. It was found that the resulting metal was in a condition outside of normal experience. The implication would seem to indicate that the response of irradiated metal to the same conditions of stress, strain, time, temperature, and service is not the same as for nonirradiated metal. Phenomena discovered from such experiments with steel to date in this country have been checked by work which has been done in Great Britain, France, and Russia. Conclusions make it unmistakably clear that very extensive studies will be required upon the part of the steel industry in the solid-state physics of metals.

Dr. Rupen Eksergian, an outstanding authority on physics, member of the staff at The Franklin Institute in Philadelphia, Pa., and consultant to industry, states:

"It is known that the properties of matter are modified by exposure to radiation and particularly to neutron radiation. There is much to be learned on the strength characteristics of all materials including steel as affected by such radiation. We are concerned with the effects of fatigue when materials are subjected to varying stress and temperature changes, upon changes in their conductivity, their elastic properties, their yield strength, and their tensile strength."

In the steel classification, he points out, welded connections raise similar concerns.

Appraising Steel Properties

Having in mind the specific application of steel to reactor design, Dr. Eksergian lists a number of factors which require consideration in the appraisal of steel properties. They are as follows:

1 "Physical strength properties at high temperatures.

2 "Fatigue strength at high temperatures with special consideration at welded connections.

3 "Thermal conductivity and specific heat at varying temperatures.

4 "Thermal-expansion coefficients and their variation at high temperatures.

5 "Radiation, heat generation, and similar properties as effected by physical properties.

6 "Neutron density absorption.

7 "Strength and fatigue properties of either bonded or welded, clad or bimetal sections."

We have been seeking to determine if the introduction and development of atomic energy will make revolutionary and abrupt changes in our industrial processes, rendering obsolete overnight countless millions of dollars in industrial equipment. The answers are becoming increasingly clear. The age-old principle seems to hold here as in other instances, that radical improvements require years, if not generations to secure widespread acceptance and application. One knows from experience that usually it takes 5 to 7 years to make ready for the commercial market a new product or process initiating in the laboratory, and another 5 to 7 years to return the investment.

Then, too, our industrial economy has become inextricably interdependent. We have no desire to cut off one hand to benefit the other. For example, many people who do not understand steel-plant practice have considered it imminently possible to eliminate blast furnaces and coke ovens through the direct use of atomic-reactor heat in steelmaking. While such a change may be in store for the future, balanced consideration of many vital factors will tend to delay any quick change.

Nuclear-Power Projects

We hear today of the rapid developments which are taking place in the adaptation of nuclear fuels to electric-power production and distribution. The Duquesne Power and Light project is under way. The Consolidated Edison Company of New York project is beyond the discussion stage. More will follow, including Commonwealth Edison's plant in Chicago. While touring England and the Continent recently, I learned that Great Britain expects to have its first full-scale atomic power plant completed by the end of 1956, and has decided to build six additional units of the same type. Another eight are considered part of the near-future program. It is no secret that the English hope to be major exporters of nuclear-power reactors for world markets. While plans in Western Europe are not yet as ambitious as in England, it stands to reason that countries such as Switzerland, Holland, and Belgium, whose industries depend so heavily upon export, will move to share in the market. It recently was proposed that the Western European countries participating in the European coal and steel community use the services of the Established Coordinating and Administrative Body for Joint Development of Atomic Reactors for power purposes. This course may be preferred to independent action by countries of relatively small size and limited resources.

In spite of the hum of research and development activity for nuclear-fueled electric-power programs in the United States, the most optimistic estimates indicate that no more than 10 per cent of our country's utility-power consumption will be generated from this source 10 years hence.

In the Public Welfare

While we may take comfort from the probability that the industrial applications and effects of atomic energy will not upset our manufacturing processes and our markets overnight, we are negligent and shortsighted indeed if we do not bend every reasonable effort within our respective companies and industries to adapt atomic energy as fully as possible to the public welfare.

Someone has observed, "The more I know of a man, the more good I find in him." It seems to me the same may be said of nuclear power. The more we understand it, the better it will serve us. Similarly, the more we understand steel and come to know its further possibilities, the greater will be its role in nuclear engineering.

Selection and Application of Spring Materials

By **Harold C. R. Carlson**, Member ASME

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This paper is intended to aid engineers and designers to select a proper spring material for each spring design quickly, easily, and accurately. The tables should obviate the necessity of undertaking a research project on spring materials each time a selection is required. This purpose is accomplished by grouping similar materials into tables and listing selection and application data in a short summary to simplify the task of selection from among the forty spring materials in general use.

ALTHOUGH much has been written on the subject of spring materials, spring manufacturers often observe that many blueprints contain incorrect specifications for materials. It is hoped that the simplified data summarized herewith will help end such confusion.

Contributed by the Machine Design Division and presented at the Diamond Jubilee Annual Meeting, Chicago, Ill., November 13–18, 1955, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Slightly condensed.

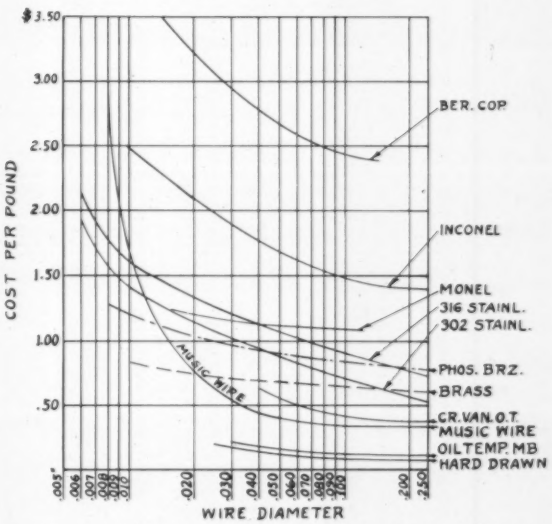

Fig. 1 Cost comparison of various spring materials

Note: Cost of Inconel X is 3 times Inconel price plus $1.00 per lb; cost of Ni-Span C is $3.00 to $8.00 per lb; cost of 17/7 PH stainless is about halfway between types 302 and 316. Cost will vary with amount purchased.

Table 1 High-Carbon Spring Steels

General. High-carbon spring steels are the most commonly used of all spring materials. Try to use these materials in preference to others because they are the least expensive, are readily available, easily worked, and most popular. These materials are not satisfactory for high or low temperatures or for shock or impact loading.

Material (commercial name)	Specifications—(in common use)	Data for Selection and Application
Music Wire Carbon 0.80–0.95%	ASTM A228-51 SAE 1085 USN 22W11C USA 48-18 AN AN-W-17 MIL W-6101 FED QQ-W-470 AMS 5112C	This is the best, toughest, and most widely used of all spring materials for small springs. It has the highest tensile strength and can withstand higher stresses under repeated loading than any other spring material. Readily available in diameters from 0.005 to 0.125 in. and in some larger sizes up to $^3/_{16}$ in. Do not use in temperatures above 250 F or for subzero temperatures. It is not available with high tensile strengths in square or rectangular sections. It can be easily plated and is obtainable pretinned or preplated with cadmium, but plating after manufacture is usually preferred, when 100-hr salt-spray test is required.
Oil-Tempered MB Grade Carbon 0.60–0.70%	ASTM 229-41 SAE 1065 USN 47S4 USA 48-7A FED QQ-W-474	This general-purpose commonly used spring steel is used for many types of coil springs where the cost of music wire is prohibitive and in sizes larger than available in music wire. Do not use for shock or impact loading. Readily available in sizes from 0.125 to 0.500 in., but both smaller and larger sizes may be obtained. Do not use in temperatures above 350 F or for subzero temperatures. Square and rectangular sizes are obtainable in fractional sizes. Annealed stock also can be obtained for hardening and tempering after coiling. This material has a heat-treating scale that must be removed before plating can be done.
Oil-Tempered HB Grade Carbon 0.75–0.85%	SAE 1080	This material is similar to the MB Grade except that the higher carbon content provides a higher tensile strength to withstand higher operating stresses. It is obtainable in the same sizes and has the same applications as the MB Grade, but is not so readily available in the plants of many spring manufacturers. Usually, where this material is specified, it may be better to use an alloy spring steel, particularly if a long fatigue life or high endurance properties are needed. Round and square sections are obtainable in the oil-tempered or annealed conditions.
Hard-Drawn MB Grade Carbon 0.60–0.70%	ASTM A227-47 SAE 1065 FED QQ-W-465	This material is the cheapest spring steel commonly used for general-purpose springs where cost is the most important factor. Increasing use of this material in recent years has brought about improvements in its qualities, but it is best specified for those applications where long life and accuracy of loads and deflections are not too important. Available in diameters from 0.031 to 0.500 in. and in some smaller and larger sizes also. Do not use above 250 F or for subzero applications. This material can be readily plated. Square sections also obtainable, but at reduced tensile strengths.

Table 2 Alloy Spring Steels

General. The alloy spring steels have a definite place in the field of spring materials, particularly for conditions involving high stress and for applications where shock or impact loadings occur. Alloy spring steels also can withstand both higher and lower temperatures than the high-carbon steels and are obtainable in either the annealed or pretempered conditions.
Note: These materials are not regularly stocked in a wide variety of sizes.

Material (commercial name)	Specifications (in common use)	Data for Selection and Application
Chrome vanadium	ASTM 231-41 SAE 6150 USN 46S31 USA 48-7A AMS 6450 FED QQ-W-474	This is the most popular alloy spring steel for conditions involving higher stresses than can be used with the high-carbon spring steels and where fatigue and long endurance are needed. Also satisfactory for shock and impact loading. Extensively used in aircraft-engine valve springs and for temperatures up to 425 F. Available in diameters from 0.031 to 0.500 in. and in some larger sizes also, and in square sizes in fractional dimensions. Both the annealed and pretempered types are available in round, square, and rectangular sections. ASTM 232-47 covers a special grade for Valve Spring Wire.
Silico-manganese	ASTM A59-49 SAE 9260 USN 46S31 USN 47S27 FED QQ-S-474	This alloy steel is quite popular in England where it is made under unusually strict conditions. It is less expensive than chrome-vanadium. It was formerly used extensively in the U. S. A. for knee-action springs in automobiles, but has been replaced by the chromium steels 5150 and 5160. This alloy is quite extensively used in flat leaf springs for trucks and as a substitute for more expensive steels. Round, square, and rectangular sections in both annealed and pretempered conditions are obtainable in sizes from 0.031 to 0.500 in.
Chrome-silicon	SAE 9254 USN 46S31	This fairly new alloy is an excellent material for highly stressed springs requiring long life and subjected to shock loading. It was developed originally for recoil springs for antiaircraft guns. This material can be heat-treated to higher hardnesses than other spring steels to obtain high tensile strengths. Rockwell hardnesses of C50 to C53 are quite common and may be used in temperatures up to 475 F. Diameters from 0.031 to 0.500 in. are most popular. This material is usually ordered specially for each job. It is rarely used in square, flat, or rectangular sections.

Table 3 Stainless Spring Steels

General. The use of stainless spring steels has increased considerably in recent years. Several new compositions are now available to withstand corrosion. All of these materials can be used for high temperatures up to 550 F, but only the "18-8" compositions should be used at subzero temperatures.

Material (commercial name)	Specifications (in common use)	Data for Selection and Application
Stainless Type 302 ("18-8") Nickel 18% chromium 8%	ASTM A313 SAE 30302 USN 48S18	This is the most popular of the stainless spring steels because it has the highest tensile strength and has quite uniform properties. It is cold-drawn to obtain its mechanical properties and cannot be hardened by heat-treatment. This material is nonmagnetic only when fully annealed and is slightly magnetic due to the cold-working performed to produce spring properties. It usually has a thin coating on the surface to lubricate the wire for use in spring coiling machines and does not have the bright surface customarily associated with polished specimens. Suitable for elevated temperatures up to 550 F and for subzero temperatures with excellent corrosion-resistance properties. Diameters from 0.005 to 0.1875 in. have the best properties, and some larger diameters are available. Also obtainable in hard-rolled flat strip. Square and rectangular sections are infrequently used.
Stainless Type 304 ("18-8")	SAE 30304 USN 46S18 USA 48-37	This material is quite similar to type 302, but has better bending properties and about 5 per cent lower tensile strength. It is a little easier to draw, due to the slightly lower carbon content. It is frequently used as an alternate to type 302 in a most satisfactory manner where stresses are not too high.
Stainless Type 316 ("18-12-2")	SAE 30316 USN 22W13 USN 47S21 A&N AN-W-23	This type is also similar to type 302, but has slightly better corrosion resistance, due to the higher nickel content; especially in sulphurous surroundings. This type is preferred by the Army and Navy for aeronautical springs even though its tensile strength is 10 to 15 per cent lower than type 302.
Stainless Type 17-7 PH	Special	This new alloy containing 17 per cent chromium, 7 per cent nickel, and small amounts of aluminum and titanium is formed in a moderately hard state and then precipitation-hardened at relatively low temperatures for several hours to produce tensile strengths nearly comparable to music wire. This material is not readily available in all sizes, and has limited applications due to its high manufacturing cost.
Stainless Type 414	SAE 51414	This straight-chromium, low-nickel alloy can be obtained hard drawn in diameters up to 0.1875 in., but has tensile strengths about 15 per cent lower than type 302. It can be hardened by heat-treatment. It should be very clean or highly polished for best corrosion resistance. It is most commonly used in flat cold-rolled strip for stampings. Not satisfactory for low temperatures.
Stainless Type 420	SAE 51420	This is the best stainless steel for large diameters above 0.1875 in., and it frequently is used in smaller size, such as 0.057 in. for recoil springs in Garand rifles. It is most used in the annealed condition and then hardened and tempered after forming. This material does not have stainless properties until after it is hardened. Clean bright surfaces provide best corrosion resistance. Therefore heat-treating scale must be removed. Bright hardening methods are preferred.
Stainless Type 431	SAE 51431	This new spring alloy contains 16 per cent chromium and 2 per cent nickel and acquires high tensile properties by a combination of heat-treatment to harden the wire plus cold-drawing after heat-treatment. This combination produces tensile strengths nearly the same as music wire and many applications for this new material arise although its corrosion resistance is not equal to type 302.

Scope of Tables

Data pertinent to the selection and application of the commonly used spring materials and the most popular alloys and special materials are included in the tables. Sufficient information is summarized so that choosing the proper material can be done easily and quickly. Additional safeguards and warnings are included so that certain materials having high cost will not be specified when less expensive and more readily available materials which may be satisfactory, can be used.

Convenience in quickly selecting a material for a

Table 4 Copper-Base Spring Alloys

General. Copper-base alloys are important spring materials because of their good electrical properties combined with their excellent resistance to corrosion. Although these materials are more expensive than the high-carbon and the alloy steels, they nevertheless are frequently used in electrical components and in subzero temperatures. All copper-base alloys are drawn to the American wire gage (same as Brown & Sharpe gage) and are nonmagnetic.

Material (commercial name)	Specifications (in common use)	Data for Selection and Application
Spring brass Type (70-30)	ASTM B134-52 SAE 80 FED QQ-W-321(C)	This material is the least expensive and has the highest electrical conductivity of the copper-base alloys. It has low tensile strengths and poor spring qualities, but is extensively used in flat stampings and where sharp bends are needed. It cannot be hardened by heat-treatment and should not be used in temperatures above 150 F, but is especially good at subzero temperatures. It is a hard-drawn material and usually used in the "spring hard" temper. It is available in round sections and flat strip.
Phosphor bronze Type 5% tin	ASTM B159-52 SAE 81 USN 22W5 FED QQ-W-401 (Strip is ASTM B 103 Grades A & C)	This alloy is the most popular of this group because it combines the best qualities of tensile strength, hardness, electrical conductivity, and corrosion resistance with least cost. It is more expensive than brass, but can withstand stresses 50 per cent higher. This material is frequently used for contact fingers in switches, due to its low arcing properties. It cannot be hardened by heat-treatment. It can be used in temperatures up to 212 F, and for subzero temperatures and is available in round sections and in flat strip, usually in the "extra hard" or spring hard tempers. The 8 per cent tin composition is used principally for flat strip. A new superfine grain composition called "Duraflex" has exceptionally good endurance properties.
Beryllium copper	ASTM B197-52 AMS 4725A MIL C-6941A	This alloy can be formed in the soft or annealed condition and then precipitation-hardened after forming at temperatures around 600 F, for 2 to 3 hr which produces a high hardness combined with a high tensile strength. It is the most expensive of this group of alloys and costs about 3 to 4 times as much as stainless steel. The principal use of this alloy is for carrying electric current in switches and in electrical components. Heat-treating frequently is expensive due to the need for holding the parts in fixtures to prevent distortion. After hardening, the material become squite brittle and can withstand very little or no forming. Improved methods of manufacture and better finishing produces flat strip that is frequently used for contact fingers.

Table 5 Nickel-Base Spring Alloys

General. Nickel-base alloys are especially useful spring materials to combat corrosion; to withstand both elevated and below-zero temperature applications and their nonmagnetic characteristic is important for such devices as gyroscopes, chronoscopes, and indicating instruments. These materials have high electrical resistance and should not be used for conductors of electrical current.

Material (commercial name)[a]	Specifications (in common use)	Data for Selection and Application
Monel- nickel 67% copper 30%	USN 46M7 FED QQ-N-281 MIL N-894	This material is the least expensive of the nickel-base alloys. It also has the lowest tensile strength of such alloys but is useful due to its corrosion resistance to sea water and because it is nearly nonmagnetic. It can be subjected to stresses slightly higher than phosphor bronze and nearly as high as beryllium-copper. This alloy acquires its high tensile strength and hardness by cold-drawing and cold-rolling only and is not amenable to hardening by heat-treatment. It can be used in temperatures between —100 and 425 F at normal operating stresses and is available in round wires up to $^{3}/_{16}$ in. with quite high tensile strengths. Larger sizes and flat strip are obtainable with lower tensile strengths. Often used in equipment having contact with food and beverages.
"K" Monel- nickel 66% copper 29% aluminum 3%	USN 46N5a FED QQ-N-281 MIL W-4471 MIL N-17505A	This material is quite similar to Monel except that the addition of aluminum transposes it to the precipitation-hardening group of alloys. It may be formed in the soft or fairly hard condition and then hardened by a long-time age-hardening heat-treatment to obtain a tensile strength and hardness above Monel and nearly as high as stainless steel. It is used in sizes larger than those usually used with Monel, is nonmagnetic and can be used in temperatures from —100 to 450 F at normal working stresses under 45,000 psi.
Inconel- nickel 78% chromium 14% iron 7%	USN 47N12 & OS-651 & W-41 FED QQ-W-390	This is one of the most popular of the nickel-base nonmagnetic alloys because it has excellent corrosion resistance and ability to be used at temperatures as high as 700 F. It is more expensive than stainless steel, but less expensive than beryllium copper. This alloy obtains high tensile strength and hardness above that of "K" Monel, by cold-drawing and cold-rolling only and cannot be hardened by heat-treatment. Wire diameters up to $^{1}/_{4}$ in. have the best tensile properties. Often used in steam valves, regulating valves, and for springs used in boilers, compressors, turbines, and jet engines.
Inconel "X"- nickel 70% chromium 16% iron 7%	Special	This material is quite similar to Inconel except that the addition of small amounts of titanium, columbium, and aluminum change it to a precipitation-hardening alloy. It can be formed in the soft or partially hard condition and then hardened by holding it at 1200 F for 4 hr. It is nonmagnetic and can be used in larger sections than Inconel at higher tensile strengths. It also may be used at high temperatures up to 850 F at stresses up to 55,000 psi.
Duranickel- ("Z" nickel) nickel 98%	Special	This high-nickel alloy is a nonmagnetic corrosion-resistant high-tensile-strength material hardenable by precipitation hardening at 900 F for 6 hr. Although it may be used at the same stresses as Inconel, it should not be used in temperatures above 500 F, and in most applications, Inconel is used to replace this alloy, at less cost.

[a] All these commercial names are trademarks of the International Nickel Company.

particular application has been the basis for the arrangement of the tables. Cost of such materials is included in the curves, Fig. 1, which also should be consulted even though in some cases, "cost is no object." Up-to-date managers know that increasing competitive advantages of low-cost materials is essential to the life of a company. And, it should be interesting to those engineers who are cost-conscious, that in certain sizes the expensive stainless steels are less costly than music wire or phosphor-bronze.

Table 6 Flat High-Carbon Spring Steels

General. Although several types of thin flat strip are obtainable for specific applications in watches, clocks, and certain instruments, only two types are readily available. These two compositions are used for over 95 per cent of all applications requiring flat high-carbon strip. Although these materials are frequently plated, thin sections under 0.015 in. having carbon content over 0.85 with hardness over Rockwell C47, are highly susceptible to hydrogen-embrittlement even though special plating and heating operations are employed.

Material (commercial name)	Specifications (in common use)	Data for Selection and Application
Cold-rolled spring steel, blue-tempered or annealed; carbon 0.70–0.80	SAE 1075 (SAE 1064 & 1070 are also used)	This is the most popular flat cold-rolled spring steel. It is readily available in a wide variety of thicknesses from 0.005 to 0.062 in. and in some thinner and thicker sections. It is carried in stock at mills and warehouses where it is slit to widths desired. The slit edges are squared or rounded by pulling the strip between stationary files. The material is available in the annealed condition for forming in 4-slide machines and in presses, and can be readily hardened and tempered after forming. Also available in the heat-treated or blue-tempered condition. Widely used for spring clips, flat springs, clock springs, motor, power, and spiral springs. This steel is also made by flattening annealed round wire, thus obtaining round edges, and then heat-treating. This material may be obtained with several finishes such as straw color, blue color, black, or plain. Hardness ranges of Rockwell C42 to C46 are recommended for springs.
Cold-rolled spring steel, blue-tempered clock steel; carbon 0.90–1.05	SAE 1095	This popular type, used principally in clocks and motor springs, can withstand higher stresses than the SAE 1075 type, but it should be used principally in the blue-tempered condition. Annealed steel, although obtainable, does not always properly harden during heat-treatment as it is a "shallow" hardening type. Useful for instrument springs and flat springs that have limited forming requirements. Spiral and clock springs usually have the end sections annealed for bending or piercing operations. Very similar in other respects to SAE 1075. Rockwell hardnesses of C47 to C51 are used for springs.
Other flat materials	...	When selecting a material for flat springs, consideration should also be given to using: brass, phosphor-bronze, beryllium-copper, stainless steels, and nickel alloys as all these materials are frequently used in strip form.

Table 7 Constant-Modulus Alloys

General. Special nickel alloys having a constant modulus of elasticity over a wide temperature range are highly desirable for springs subjected to temperature changes; especially where the springs must exert uniform loads and deflections. These materials having a low or zero thermoelastic coefficient eliminate variations in the stiffness of springs caused by modulus value changes due to temperature differentials. These corrosion-resistant alloys having uniform and nearly constant elastic characteristics also have low hysteresis and low creep values, making them preferred materials for food-weighing scales, precision instruments, gyroscopes, measuring devices, recording instruments and computing scales where temperature changes are within the range of −50 to +150 F. These materials are quite expensive; none is regularly stocked in a wide variety of sizes and they should not be specified without prior discussion with spring manufacturers because some suppliers may not fabricate springs from these alloys because of the special manufacturing processes required. All these alloys are used in small wire diameters and in thin strip only and are covered by U. S. patents.

Material (commercial name)	Type	Data for Selection and Application
Elinvar	Nickel-iron-chromium	This alloy developed in France was the first of the constant-modulus materials used for hairsprings in watches. It is an austenitic alloy hardened only by cold-drawing and cold-rolling. Modifications to this basic alloy by the addition of titanium, tungsten, molybdenum, and other alloying elements have brought about improved characteristics and precipitation-hardening abilities, exhibited by Ni-Span "C" and other materials having trade names such as "Elinvar Extra," "Durinval," "Modulvar," "Nivarox," etc. This basic alloy is still used in applications described in the heading of this table, but other alloys described below are more useful.
Ni-Span "C"	Nickel-iron-chromium-titanium	This is the most popular of the constant-modulus alloys, and was developed by the International Nickel Co. It is usually formed in the 50 per cent cold-worked condition and precipitation-hardened at 900 F for 8 hr, although heating to 1250 F for 3 hr produces hardnesses of Rockwell C40 to C44; permitting safe torsional stresses of 60,000 to 80,000 psi. This material is ferromagnetic up to 400 F, and then becomes nonmagnetic at higher temperatures.
Iso-Elastic	Nickel-iron-chromium-molybdenum	This popular alloy for scales was developed by John Chatillon and Sons and is easier to fabricate than Ni-Span "C." It is used principally in dynamometers, instruments, and food-weighing scales, where its temperature-compensating characteristics meet the requirements of national and state boards of weights and measures. Safe torsional stresses of 40,000 to 60,000 are used with Rockwell hardnesses of C30 to C36.
Elgiloy 8J Alloy Durapower Cobenium	Nickel-iron-chromium-cobalt	This alloy, bearing four names, was developed by the Elgin Watch Co., in co-operation with Battelle Memorial Institute and three steel and wire-producing companies. It is a nonmagnetic alloy suitable for subzero temperatures and up to about 1000 F, provided torsional stresses are kept under 75,000 psi. It is precipitation-hardened at 900 F for 8 hr to produce hardnesses of Rockwell C48 to C50. It is used in Elgin watches and instruments.
Dynavar	Nickel-iron-chromium-cobalt	This alloy, developed by the Hamilton Watch Co., is a nonmagnetic, corrosion-resistant material suitable for subzero temperatures and up to about 750 F, provided torsional stresses are kept under 75,000 psi. It is precipitation-hardened to produce hardnesses of Rockwell C48 to C50 and is used in Hamilton watches and instruments.

The field of application covering the forty most popular spring materials as summarized in the tables, should help engineers to select the most suitable material for each application. Detailed descriptions of chemical compositions, mechanical properties, and physical constants are available in the material specifications listed or are obtainable from spring and wire manufacturers.

In addition to the materials covered, occasional use is also found for springs made from wood (hickory and ash are best), plastic (laminated phenolic and thermoplastic types), glass (used in acids), aluminum, and other special alloys.

ASME Rubber and Plastics Division . . .

. . . reviews progress in fields of rubber and plastics to the present time with special emphasis on the accomplishments of 1955.[1]

THE 1955 ASME Annual Meeting program of the Rubber and Plastics Division consisted of three technical sessions: a Rubber Session, General Session, and a Plastics Session.

The subject matter of the various sessions was so arranged as to provide a thorough review of the progress in the fields of rubber and plastics to the present time with special emphasis on the accomplishments of the past year. The General Session provided a comprehensive summary of the position of the rubber and plastics engineer in science and industry.

Rubber Session

In the first paper on "Uses of Rubber in Home and Industry—Past, Present, and Future," E. J. Joss, U. S. Rubber Company, reviewed the tremendous growth of usage of rubber goods in both home and industry.

Mr. Joss effectively covered the growth and progress of rubber usage in industry by analyzing the various applications as associated with the specific properties of the material such as energy absorption, flexibility and compressibility, wear resistance, fluid impermeability, skid resistance, adhesiveness, chemical inertness, electrical conduction and insulation, and thermal insulation. The many impressive examples discussed under each heading provide a valuable review of the wide scope of applications to all phases of our industrial community. They furthermore are a credit to the many engineers whose work produced these milestones of progress.

The paper further provides a good summary of the new rubber materials recently developed, and comments upon the application of the unusual properties of many of these to the possible solution of problems of the present and future in industry, aviation, and transportation.

H. H. Waters of the Firestone Tire and Rubber Company, in his paper, "Use of Rubber in Transportation—Past, Present, and Future," presented a brief review of the history of the contributions of rubber to transportation from early times to today's tubeless tire. The growing acceptance of this latter development and its advantages was discussed. The tremendous contribution of the synthetic rubbers to transportation was emphasized and an historical summary of growth set forth.

The applications of synthetic rubber to foam applications were noted, and the latest developments of polyurethane foams were briefly discussed.

The outstanding application of rubber to air springs was especially interesting. The importance of the progress in this field indicates a real advance in life, and better road characteristics, that promise to move into wide usage as an improvement over conventional spring suspensions in transportation.

A development of a new synthetic rubber directly comparable to natural rubber is deemed to be of great importance in the progress of the rubber industry as well as to the security of the nation with a possible reduction or dissolution of the costly government stockpile now maintained.

The advantages and future of rubber roads and pavements indicate a large new possible market and improvement in transportation.

"Engineering Developments of Rubber—1954 – 1955," by Lillian Cook, University of Akron, and Leora E. Straka, Goodyear Tire and Rubber Company, was the last paper of the Rubber Session.

The authors presented a comprehensive paper, carefully referenced to a very complete bibliography that will be a valuable tool to all engineers, or laymen, interested in the field of rubber progress. The literary contributions concerning the duplication of natural rubber were well summarized with a comparison of the basic properties of each to those of the natural material.

Of special interest was the discussion presented concerning the vulcanization of various rubbers by gamma radiation with the results directly compared to those obtained by chemical vulcanization. It was carefully pointed out that the progress in this field is too new to be conclusive, and examples of degradation problems were shown in contrast to the numerous promising improvements set forth. The development of "Anti-Rads," added to stocks prior to vulcanization, appeared to help shield them from the effects of radiation. Notwithstanding the relative infancy of this new approach, progress is being made, and it conceivably can change the entire future picture of the rubber process in years to come.

The paper also discussed colored side-wall tires, tire design, the progressive changes in that field, the application of rubber in roads, industrial seals, and the chemistry, compounding, and testing of the new rubber materials.

This is an excellent review of progress during the past year and should be thoroughly read by those interested in the field.

General Session

In the opening paper, "The Engineer in Education," by Prof. C. C. Winding, Cornell University, the author emphasized the position of the engineer as being faced with rapid change, and increasing complexity of a "splintering-off" process into more and new specializations. These same factors make demands upon the

[1] Summary by William R. McLain, Mem. ASME, president, Kusan, Inc., Nashville, Tenn.

Based on papers contributed by the Rubber and Plastics Division and presented at the Diamond Jubilee Annual Meeting, Chicago, Ill., Nov. 13–18, 1955, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

colleges and universities to appraise carefully their training curricula to fit into this new engineering age. The problem of restricting curricula to cover more of the scientific engineering background, and less of the general, is one of major concern, because the end product as a graduate must face even greater demands of latitude, leadership, and ethics than ever before. The author suggested, as a possible solution, heavier emphasis on the basic and engineering sciences with elimination, or reduction, of the arts and practices of engineering, but with a preservation of a study of the humanities. It would seem that if further emphasis be placed as indicated on a four-year curricula (and the author indicates five years as more appropriate, in his opinion) that most of the load of education beyond this must fall in greater growth of the graduate schools. Further, it indicates the responsibility that must, and should, be shouldered by industry in further training and education after employment. This latter was the comment of the technical chairman, Glen Neely, Mem. ASME, The Richardson Company, and probably concurred with by the author.

F. E. Reese, Monsanto Chemical Company, in his paper, "The Engineer Has a Place in Research," drew an effective analysis and comparison of the research engineer to the design engineer in modern industry. The design engineer was defined as one who used basic engineering science in application to bringing the product to productive fruition after its creation. He pointed out that the research engineer must be somewhat of a dreamer, bold, and perhaps unconventional, while the design engineer must use imagination in the application of known facts.

The problem of supervision and relation between the two types of engineering were discussed interestingly.

The analysis of personnel as to their suitability for research was covered, and the problem of evaluation of the research engineer's work was noted. Good examples of a typical organization, and its assignments and co-operative work for mutual progress were shown in numerous charts and descriptions.

Mr. Neely, the technical chairman, commented that it is obvious in an ever-growing technical age that the role of the research engineers will become increasingly important, but his real value will also lie in his ability to recognize over-all economics and the imperative demand for an understanding of the fundamental requirements of other phases of the industry.

"The Engineer in Production," by Robert A. Merrill, United States Rubber Company, was the third paper of the General Session.

Mr. Merrill noted that the over-all progress of industry, as well as the progress of our country, rested on engineering achievement as probably the most important factor. He noted the various types of engineers who contributed to all phases of industry and production. Emphasis was placed on the fact that with the trends toward more complete automation the demands on the engineer become greater and greater to provide simplified methods, machines, processes, and controls. This also applies to the paper-work end of the business in preparation of reports, analyses, and records.

The paper covers well the role played by the engineer in production, and the increasing demands of the future. As the author sums it up—"Production *is* the Engineer."

In the closing paper of the session, "The Engineer in the World of Commerce and Industry," Donald L. Gibb of The Dow Chemical Company, presented an effective picture of the position of the engineer with regard to sales. He emphatically showed the close tie that must exist between sales and engineering in an increasingly technical world. He also pointed out the importance of the engineer having a concept of sales and profits. He drew an interesting analogy of the result of engineering without these factors being fully developed. The importance of the profit system to the growth of the engineer, as well as to the over-all economy, was emphasized. The technical chairman commented that this factor is often played down, or overlooked, to the point that it becomes one of the major problems of industry to instill this understanding into its engineers, as well as other key personnel. The paper was most timely.

Plastics Session

The proper selection and application of materials, together with their proper combination with other materials, were cited by W. E. Manring, B. F. Goodrich Chemical Company, as the key to expanded use of plastics in home and industry. Mr. Manring's paper was titled, "The Use of Plastics in Home and Industry—Past, Present, and Future." A comparison of the physical and thermal properties of the various plastic materials with relation to basic structural materials such as glass and steel was made by use of various charts and data.

The properties that are important to the growth of plastics in these fields were outlined and an analysis of each was made. These were listed as: (1) Ability to meet the use requirement, (2) extended durability, (3) lightweight, (4) optical transparency, (5) aesthetic appeal, and (6) low fabrication cost.

A résumé of uses in the building field included the ten-year life expectancy of an over-all skin applied to an external structure, the development in construction applications, plastic piping, siding, glazing, facings, gutters, and so on.

In the field of industry the corrosive resistance of plastics was deemed to be of primary importance, and examples and data of applications with regard to time, temperature, and corrosive elements were outlined. It was noted that better information regarding the possible life and creep characteristics of plastic materials was among the important necessities to greatly expanded growth.

It was pointed out that the proper use of plastic materials in combination with other materials, a suitability for the application, and a consideration of the economics involved form the basis of selection. The unusual advantageous technical properties of the material make them ideally suitable for many specific applications and as their properties, economics, and processes are better understood and developed that an ever-expanding use of plastics in the fields of home and industry may be realized.

K. K. Fligor of the Goodyear Tire and Rubber Company, in his paper, "Plastics in Transportation," pointed out that the major use of plastics in transportation today was in the fields of the aircraft and automotive industries. Other transportation means utilizing plastics to sizable degrees were indicated as being pipes for liquids and gases, conveyer belts for bulk movements, bus, truck, and marine applications. It was

(*Continued on page 340*)

Plastics as Mechanical-Engineering Materials

Plastics are highly adaptable materials covering a wide range of properties and fabricated methods. Complete freedom from corrosion can be obtained and large or small objects of complicated shape can be formed in a single operation.

By Johan A. Bjorksten

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THE art of mechanical engineering is closely related to the structural materials available.

Archimedes—the great mechanical engineer who with his inventions held the conquering Romans at bay outside the walls of his native Syracuse in 211 B. C.—said, "Give me but one fixed point in space and I shall be able to lift the earth." He did not specify what material he would use for the levers in his lifting mechanism. But if he were here today and were given his fixed point, the chances are that he would choose a glass-fiber-reinforced phenolic, polyester, or epoxy resin. For on the basis of strength-to-weight ratio, where modulus is not critical, these materials have advantages over steel, titanium, and aluminum.

Today, plastics offer at least as wide a range of properties as metals and there are many structural applications where their use is advantageous. In this respect, we must take into account not only mechanical properties, but particularly the various fabrication processes which can be applied to the different types of plastics.

Where to Use Plastics

The following types of situations seem particularly adaptable to the use of plastics:

1 Where an article with a compound curvature is to be made, and the run is too short to permit amortization of metal dies; for example, short runs of automobile chassis or boats.

2 Where the greatest possible strength-to-weight ratio is to be achieved; for example, sucking rods for oil wells, lifting rods or cables for deep-sea or deep-mine work, wings for missiles, aircraft components, railroad freight-car bodies, and receptacles for sensitive, expensive equipment or materials.

3 Where a severe corrosion problem exists, for example, the use of plastics having complete resistance to salt-water corrosion for piping in the oil fields. Wherever rapid laying of long stretches of pipes without joints is desired, a pipe extruder mounted on caterpillar treads could be used to lay down continuous pipe. A patent disclosing such a device was issued recently.

4 In making forming tools, particularly where the dimensions of the tools are very large and the cost of steel precision tools therefore would be excessive.

5 Where dimensional stability and transparency are simultaneously required, as in the use of phototemplates. In all cases where it has been the practice to make drawings on glass or metal for permanence, it will be economical to make the drawings on phototemplates.

6 To increase the rigidity of hollow members, such as airplane propellers, by filling them with a rigid foam.

7 Where thermal-insulating properties are desired. The thermal-insulating properties of plastics have a twofold application: namely, (1) at low temperatures where heat loss is to be kept down, as in refrigerator parts, and (2) where temperatures of several thousand degrees are encountered for a short time only, so that the heat has no time to penetrate and weaken the plastic. In the second application corresponding metal parts would be fused or weakened in the same time.

8 Where transparency is needed for optical stress analysis of complex shapes.

9 Where noiseless gears are desired and the load is not excessive.

Also there are many applications of plastics in the building industry, but these were fully covered at the Conference on "Plastics in Building" held in October, 1954, in Washington, D. C.,[1] and will not be enumerated in this paper.

The weakest point in plastic fabrication has been the time factor. A large portion of the research effort in plastics has been devoted to shortening the time needed to complete the setting or curing operation. At present, phenolics and molding polyesters can be cured in a matter of a few seconds—nevertheless there is heat-transfer time involved since the mold must be heated and cooled for each cycle.

Speed-Up by Supercooling

There is a technique which would permit plastic parts to be turned out just as fast as any metal-stamping operation, but to date it has not been utilized in production. This technique is supercooling. Numerous plastics have the property that if they are heated to near their melting point and then suddenly quenched, they will remain soft, drawable, and formable for several hours to a day, after which time they will harden. Thus if a sheet made of one of the supercoolable resins were heated and then quenched to room temperature, it could be stamped or drawn to the desired form as rapidly as if it were of metal. The supercooling technique may prove particularly applicable to the rigid vinyls and to the new low-pressure polyethylenes.

Glass-Reinforced Plastics

In making articles which have compound curvatures

Contributed by the Rubber and Plastics Division and presented at a joint session of the Metals Engineering and Rubber and Plastics Divisions at the Diamond Jubilee Annual Meeting, Chicago, Ill., November 13–18, 1955, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. (Slightly condensed.)

[1] Under the sponsorship of the Society of the Plastics Industry, Inc., the Manufacturing Chemists Association, Inc., and the Building Research Advisory Board of the National Research Council.

and which serve mechanical functions, the reinforced plastics merit primary consideration. Some properties of glass-reinforced phenolics, melamines, polyesters, and epoxies which are important in engineering design are listed in Tables 1 to 4. The values given are based upon maximum and minimum figures submitted by a number of manufacturers of each plastic material.

Phenolic resins have been used particularly in components requiring good performance at temperatures higher than possible with polyesters. Some phenolic plastics show excellent mechanical strength at temperatures as high as 400–500 F.

The high-temperature advantage of the phenolics, however, has been somewhat diminished by the recent development of polyester resins which exhibit good properties when aged at 300 F and which retain much of their strength at 500 F. A very high degree of fire resistance can be attained with the Hetron type of polyesters, and these resins also give extremely high-strength reinforced products.

The epoxy resins, which are a relatively new addition to the reinforced-plastics industry, are notable for their remarkable adhesion to glass and to metal. Their edgewise compressive strength, a measure of resistance to delamination, is the highest of all resins.

Thermoplastic resins such as acrylics, vinyls, and polyethylenes have not been used to any great extent in reinforced plastics. However, reinforced materials made with these resins are postformable and thus have the great advantage of less messy fabrication operations. They should prove particularly adaptable to the type of operation which utilizes the supercooling effect to obtain split-second cycles.

The recently introduced low-pressure polyethylenes can have a tensile strength as high as 6000 psi and a stiffness modulus as high as 150,000 psi and can withstand continuous temperatures of 250 F. Complete fire resistance is attainable with the polyvinyl and vinylidene-chloride plastics.

The technique of using matched dies and a pressure of several hundred psi is gaining increasing acceptance in the manufacture of objects and components from reinforced plastics. This technique results in parts having better dimensional tolerances and higher strengths than those attainable with the older low-pressure methods.

For applications in which the greatest possible strength-to-weight ratio is to be achieved, the strength almost invariably is provided by the reinforcement. Thanks to the unique properties of glass, but also largely to the enormous amount of work which has been done in order to solve adhesion and other problems, glass fiber today enjoys a dominant position in the reinforcement field. In glass-reinforced plastics, the glass contributes strength and the plastic serves mainly to prevent the glass fibers from crushing each other because of their brittleness and lack of elasticity.

High-Strength Reinforcements

Table 5 shows examples of high-strength mechanical reinforcements, including synthetic fibers other than glass.

Orlon fibers in particular are highly attractive from the standpoint of reinforcement, because of the very fine finish they give. When pressures in excess of 25 psi are used, the Orlon fibers tend to flatten out and give a coverage in excess of that which would be expected

Table 1 Glass-Reinforced Phenol-Formaldehyde Plastics

Property	Glass-fabric-base laminates	Glass-filled molding compounds
Specific gravity	1.5–2.1	1.75–1.95
Tensile strength, psi	11500–40000	5000–10000
Tensile modulus, 10^5 psi	10–20	33
Compressive strength, psi	42000–60000	17000–26000
Flexural strength, psi	20000–40000	10000–60000
Shear strength, psi	17200–24000	...
Impact strength (Izod), ft-lb per in. of notch	3.2–16	10–50
Resistance to heat (continuous), deg F	290	350–450

SOURCE: *Modern Plastics Encyclopedia.*

Table 2 Glass-Reinforced Melamine-Formaldehyde Plastics

Property	Glass-fabric-base laminates	Glass-filled molding compounds
Specific gravity	1.82–1.98	1.9–2.0
Tensile strength, psi	25000–50000	6000–10000
Compressive strength, psi	30000–85000	9000–15000
Flexural strength, psi	28000–55000	9000–14000
Flexural modulus, 10^6 psi	30	...
Shear strength, psi	19000–30000	...
Impact strength (Izod), ft-lb per in. of notch	5–15	3–24
Resistance to heat (continuous), deg F	300	300

SOURCE: *Modern Plastics Encyclopedia*

Table 3 Glass-Reinforced Polyester Plastics

Property	Glass-fabric-base laminates	Glass-filled molding compounds
Specific gravity	1.5–2.1	1.7–2.0
Tensile strength, psi	40000–50000	4000–10000
Tensile modulus, 10^6 psi	10–28	16–20
Compressive strength, psi	30000–60000	20000–25000
Flexural strength, psi	50000–63000	5000–30000
Flexural modulus, 10^5 psi	20–30	...
Shear strength, psi	12000–18000	...
Impact strength (Izod), ft-lb per in. of notch	19–35	3–24
Resistance to heat (continuous), deg F	300–400	300

SOURCE: *Modern Plastics Encyclopedia.*

Table 4 Glass-Fabric-Epoxy-Resin Laminates

Property	Glass-fabric-base laminates
Specific gravity	1.7–1.9
Tensile strength, psi	33000–46000
Tensile modulus, 10^6 psi	25–35
Compressive strength, psi	50000–90000
Flexural strength, psi	45000–80000
Flexural modulus, 10^6 psi	20–36
Shear strength, psi	17000–22000
Impact strength (Izod), ft-lb per in. of notch	6–16
Resistance to heat (continuous), deg F	300–360

SOURCE: *Modern Plastics Encyclopedia*

Table 5 High-Strength Reinforcing Fibers

Fiber	Tensile strength, psi
Glass	250000–315000
Saponified acetate rayon (Fortisan)	138000
Nylon	88000–114000 (high-tenacity filament)
Dacron (polyester)	106000–109000 (high-tenacity filament)
Orlon (acrylic)	62000–71000
Viscose rayon	58000–88000 (high-tenacity)

from the quantity employed. The use of Orlon mat as an outer-layer reinforcement is therefore particularly desirable where a very high finish is required and where wear or erosion resistance is of great importance.

The arrangement of the fibers plays a large part in the strength properties of the plastic product. The highest strength in a given direction results from having all the reinforcing fibers parallel in that direction. This can be done either by bundling the fibers directly, before they are combined with the resin, or by suspending a mixture of $^1/_2$ to 2-in-long chopped strands in the plastic and then causing the suspension to flow so that the strands are oriented in the desired direction by streaming effects.

In applications where elasticity, or some "give" is required, it is preferable to match the elasticity of the resin with the elasticity of the reinforcing fibers. In this manner the best coaction of the resin and the reinforcement is achieved.

Table 6 indicates the elasticities of several reinforcements, along with those of resins with which they might be used.

Table 6 Elasticities of Various Reinforcements and Resins

Reinforcing fiber	Modulus of elasticity, 10^5 psi	Molding resin	Modulus of elasticity, 10^5 psi
Nylon	4.3	Epoxy	4.5
		Methyl methacrylate	4.5
		Polystyrene	4–6
		Vinyl chloride	5–6
Dynel	5.9	Polyester	3.0–6.4
Orlon	11.0		
Viscose rayon (regular filament)	9.3–13.2	Phenol formaldehyde	7.5–10.0
Cotton	8.3–16.2		

[a] Data obtained as follows:

1 Modulus of elasticity for various fibers obtained in 10^{10} dynes/cm^2 from *Modern Plastics Encyclopedia* and converted to psi by using factor

$$1 \text{ psi} = 6.8944 \times 10^4 \text{ dynes/cm}^2$$

2 Modulus of elasticity in tension for various plastics obtained in psi, from *Modern Plastics Encyclopedia*.

Table 7 Representative Production Tools Made From Plastics

Stretch dies	Assembly fixtures
Hydropress dies	Holding and locating pads
Draw dies	Drill jigs, trim and routing fixtures
Drop-hammer dies	Foundry patterns
Hammer forms	Molds for reinforced plastics
Die models and checking fixtures	
Mockups	Postforming dies

To Combat Corrosion

In unusual corrosion problems, plastics have been used with considerable success. Since coatings fall beyond the subject of this paper, ducting and piping will be discussed primarily.

Ducting—and this includes microwave guides—can be made very nicely from rigid polyvinyl chloride and no doubt from polyethylene. When it is made from polyesters, leakage problems occur because the shrinkage of these resins results in pinholes. These problems can be handled by coatings, or by the use of the low-shrinkage epoxy resins.

Almost every plastic has been considered for piping applications. Continuous lamination processes for production of plastic pipe have been devised and widely used. Extrusions have been carried out with plain resin and, lately, with reinforced material. (It is possible to feed reinforcement into the extrusion.) Lightweight tubing has been made from wound Mylar film; this film has a tensile strength of 25,000 psi.

Extruding Plastic Pipe. Particularly promising is the possibility of extruding plastic pipe continuously from an extruder mounted on caterpillar treads, so that it could follow a plow through the terrain. In this way, piping could be laid at a speed of several miles an hour with no joints, and thus with no leakage possibilities and no need for fitting or assembly of multiple sections. This method appears to be the method of the future for laying pipe lines over long distances. True, the pressure resistance will be less than that now used, but the ease and low cost of laying the lines should more than compensate for the lesser-pressure characteristics.

The use of plastic tooling has increased greatly in recent years. Table 7 lists representative production tools made from plastics. The layup of reinforcement is of great importance in tooling applications since a high degree of compactness is desired. Epoxy resins have been the most favored resins for these applications because of their low-shrinkage characteristics.

The technique of phototemplates makes it possible to reproduce very large parts with great accuracy and is therefore widely used in the aircraft, automotive, and appliance industries. Applications of phototemplates include mapping, tooling, lofting, plane-table surveying, making copies for subcontractors, and turning out prototype parts.

For the successful use of phototemplates, it is desirable to have a transparent material of higher dimensional stability to varying humidity and temperature than any of the unreinforced plastics. Certain glass-reinforced plastics, however, provide a sheet material which is substantially as dimensionally stable as plate glass.

It has long been a practice to fill thin hollow members with foam to increase their mechanical rigidity. The best-known application of this practice is in propellers for airplanes. However, numerous other applications exist, particularly in shipbuilding where the foam imparts rigidity and buoyancy at the same time. The isocyanate-type foams have been particularly successful here.

Very large savings have resulted from the adoption of plastics in the refrigerator and freezer field, because the considerable heat leakage through metal parts from the outer wall to the inner compartment has been eliminated. Corrosion problems have also been eliminated, and the use of reinforced plastics provides the high-strength characteristics required in highly stressed parts.

Table 8 gives examples of refrigerator and freezer parts made from plastics.

Mechanical-Parts Production

Corrosion-resistant mechanical parts can be produced with ease from plastics, often in a single operation. For example, gears and levers have not only been extrusion-molded from nylon, but also have been formed on screw machines from nylon, acrylic, and styrene resins.

A particular advantage of plastic gears is that a lubricant, such as graphite, can be worked in and made an

integral part of the gear composition, thus insuring permanent lubrication.

Table 8 Refrigerator and Freezer Parts Made From Plastics

Part	Plastic used
Inner-door panels	Glass-reinforced polyester, paper-base phenolic, styrene, styrene alloy
Door shelves	Glass-reinforced polyester, styrene
Breaker strips (or frames)	Styrene
Refrigerator drain rail	Vinyl
Freezer supports	Glass-reinforced polyester
Lock and latch housings	Glass-reinforced polyester
Rollers for door latch and roll-out shelves	Nylon
Tie straps (to hold outer and inner cabinets together)	Glass-reinforced polyester
Tubing and wire retainers	Glass-reinforced polyester
Wire sheathing	Vinyl
Drain stops	Glass-reinforced polyester
Evaporator drain trays	Styrene
Freezer-compartment doors	Styrene
Door-striker mounting plates	Glass-reinforced polyester
Vegetable crispers and other containers	Styrene, polyethylene
Decorative parts	Acrylic

For these applications, nylon has shown good mechanical values, where a high elasticity (up to 30 per cent stretch) is permissible. The urethanes ("Perlon") have equally good mechanical properties, but lower heat resistance and lower elasticity. Glass or asbestos-filled polyesters and epoxy resins can be used, and gears and levers of phenolic-impregnated cloth have been made for a long time.

For machining of plastic parts, standard metal and woodworking equipment can be used with the addition of a few extra tools and a revision of feeds and speeds. Machining techniques used on metal or wood also require little alteration to apply successfully to plastics if certain factors are kept in mind.

Emphasis should be placed on a good cooling system to avoid overheating of the plastic to temperatures near its melting or softening point.

Because plastic dust may be irritating to workers, all dry-machining operations should have a vacuum dust-removal system.

Attention should be given to the tendency of some plastics, particularly polystyrene, to craze when exposed under strain to solvents, including most oils.

Some of the tougher plastics, such as nylon and cellulose acetate or butyrate, and the reinforced plastics are very abrasive and cause hard wear on the machining tools. For this reason carbide abrasive wheels are often recommended for major cutting, trimming, and turning operations and carbide-tipped drills for drilling operations.

Plastics are softer than steel and thus require higher tooling speeds than those used in machining metal, in order to remove chips faster. The cutting rate is generally set at the highest speed at which overheating of the tool or plastic can be avoided; machining trials should be made to determine optimum speeds for a particular plastic.

It should be pointed out that many molded plastic parts do not require machining other than minor surfacing operations. Holes, threads, and various inserts frequently can be molded into parts thus eliminating the need for machining.

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(*Continued from page 336*)

indicated that the utility and decorative value of plastics coupled with their contributions toward comfort and safety were among the primary reasons for the use of plastics in this field.

Mr. Fligor reiterated thinking reflected in the previous paper that there is still need for better engineering data on extended aging, creep, ultimate strength, and vibration resistance. Progress in providing this needed data can further expedite additional applications in the field. The different manufacturing processes of plastics, their advantageous production possibilities, and limitations were discussed.

The experimental and developmental uses of plastics in the automotive industry indicate wide future markets as the materials are adapted or developed to meet the requirements of these applications. The resistance to corrosion, and the provision of lower center of gravity, are important attributes in the manufacture of trailers and automobiles which hold good promise for wider usage.

As materials continue to improve, and economics from fabrications savings and broader usage take effect, combined with a greater confidence and understanding of the proper engineering application, plastics should face a tremendous future market in the field of transportation.

The changing face of the industry by merger, expansion, and geographical location, as applied to suppliers, fabricators, equipment manufacturers, etc., was discussed by Bryce Maxwell of Princeton University, in his paper "A Review of Developments in Plastics Engineering—1954–1955."

Among the developments in the fields of raw materials the modification and improvements in older materials during the year was deemed significant among epoxy resins, silicones, phenolics, styrene copolymers, nylon, and polyurethanes. The importance of the developments in the field of ethylene polymers was emphasized with respect to irradiation, the sizable production increase, and the introduction of the low-pressure polyethylene materials. These materials seem to fill a gap in properties that should be a valuable contribution to the plastics field. It was also noted that application of the Zeigler process to polystyrene and polypropylene have produced different-type products that may hold considerable interest as they are further developed. The increased use of plastics in tools, jigs, and fixtures in the metalworking trade during the year, together with improved equipment and methods of moldmaking, were discussed.

Professor Maxwell emphasized the need of increased dissemination of information and wider educational training for plastics at the college level.

Engineering Developments of Rubber —September, 1954, August, 1955

Natural rubber duplicated synthetically—a high spot in rubber technology

By Lillian Cook[1] and Leora E. Straka[2]

A Goodrich Tire and Rubber Company release, dated December 2, 1954, announced that a new synthetic rubber exactly duplicating tree rubber had been developed. The new rubber does not contain styrene or butadiene. A few months later two other companies made similar announcements.

Ample Supply of Raw Materials

Although it is claimed that the raw materials are in ample supply in this country, the specific reagents have not been disclosed by Goodrich. Known as "Ameripol SN," the new product is supposed to possess all the physical properties of tree rubber, even down to the traditional stickiness. X-ray patterns show a close similarity of "Ameripol SN" and tree rubber (Fig. 1) (1–7).[3]

Since the new material is still in the research stage, the company has announced plans to build a pilot plant in northern Ohio to produce enough of the rubber for further tests. Although the plant is expected to be in operation within a year, it is estimated that rubber cannot be supplied for tires for at least five years (8–12).

Large truck tires have been made of the new rubber and are now being tested on American highways. The tires give mileage and over-all service which is stated to be superior to tires made of other synthetic rubbers. According to available reports, the new synthetic requires little or no difference in the techniques required to make the tires with the new rubber and those generally employed when crude rubber is used. Present results indicate that the new rubber is a reproduction of the true molecule of crude rubber, and that it is entirely practical for use in the manufacture of large truck tires (13–18).

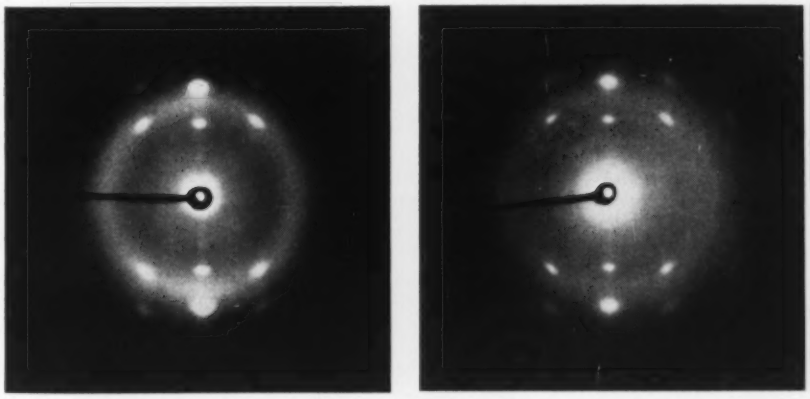

Fig. 1 At left, x-ray pattern of Ameripol SN, new synthetic rubber, compared with x ray of natural rubber at right

Firestone Pilot Plant

The Firestone announcement appeared on August 22, 1955, and revealed that its pilot plant had been in production for two years. Firestone stated that the patent rights, research data, and small experimental quantities of the new rubber were being offered to the Department of Defense and the rubber industry in the national interest of establishing a reliable domestic source of supply of rubber that would be the equivalent of natural rubber for use in military truck tires. The new rubber, made from isoprene derived from petroleum and polymerized by ionic type (alkali metal) catalyst, is a cis-1,4-polyisoprene which contains neither trans-1,4 structure nor distinguishable amounts of 1,2 structure. This has been shown by infrared analysis and x-ray pattern. The x-ray pattern, Fig. 2, shows the orderly molecular

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[3] Numbers in parentheses refer to the Bibliography at the end of the paper.

Contributed by the Rubber and Plastics Division and presented at the Diamond Jubilee Annual Meeting, Chicago, Ill., November 13–18, 1955, of The American Society of Mechanical Engineers.

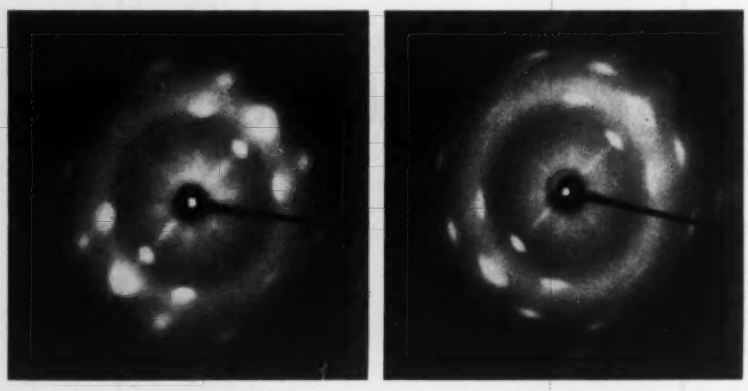

Fig. 2 X ray of natural rubber (left) and Coral rubber made from isoprene (right)

structure characteristic of crystalline polymers. The crystalline reflections appear as bright spots. Similarity of the pattern (right) with that of natural rubber (left) is particularly significant, although the new rubber was stretched about twice as much as the natural rubber (19–25).

Coral Rubber. The new rubber, called "Coral Rubber," is characterized by high gum tensile strength (about ten times that of cold GR-S and about 90 per cent that of natural rubber), low hysteresis (heat build-up), and good retention of properties at high temperatures. The cracking resistance and thermal stability of stocks made from this new synthetic are claimed to be superior to those of natural rubber, attributed to a slight difference in structure which makes the new rubber more resistant to oxidation. Coral Rubber uses the same types of reinforcing agents and softeners as natural or GR-S synthetic, and the effect of the agents is similar for all three. However, the new synthetic breaks down much more easily than GR-S, so the amount of softeners and plasticizers used is generally less—similar to amounts needed with natural rubber. When reinforced with carbon black, the material has a strength two to four times that of GR-S at elevated temperatures. Because it has an inherent tackiness which other synthetics lack, Coral Rubber is easier to work with in the factory than GR-S, and it can be processed and fabricated without application of special processes or additional processing (22, 26, 19).

Truck-Tire Requirements. The hunt for a better synthetic was necessitated by the fact that large truck tires generate much heat under heavy loads, and heat is the main enemy of rubber. Until the recent duplication of natural rubber, no synthetic had been developed which could endure this heat. Furthermore, natural rubber in truck and airplane tires accounts for some 30 per cent of the total annual tonnage of new rubber consumed in the United States (3). Over a half-million miles of tests have been completed with tires made of Coral Rubber. The new rubber develops only about half the heat that present synthetics do, and is equivalent to natural rubber in this respect. The treads show wear resistance up to 95 per cent of that of natural rubber. Firestone has not definitely stated that this synthetic rubber will replace natural rubber for all purposes (19, 20, 22).

Competitive With Natural Rubber. Both companies estimate production techniques can be improved to place the new synthetic in competition with natural rubber. This synthetic tree rubber cannot be made in the existing GR-S plants. Since GR-S has its own wide range of usage, it will not be affected seriously by the new product. Among major rubber uses, only truck tires have resisted competitive manufacture by synthetics. This leads some to believe that the pilot-plant production will be the beginning of a development which ultimately will eliminate demand for the tree-grown product. Whether this is true or not remains to be seen but certainly it can be assumed that if and when the new rubbers actually can compete with the natural product, they can effectively place a ceiling upon its price. Also, if the rubber can be made in volume, it definitely would lessen and possibly eliminate the need for a national rubber stock pile (2, 3, 5, 6, 11, 15, 16, 26, 27).

Goodyear's Development

Just several weeks ago the Goodyear Tire & Rubber company announced the synthesis of a polyisoprene

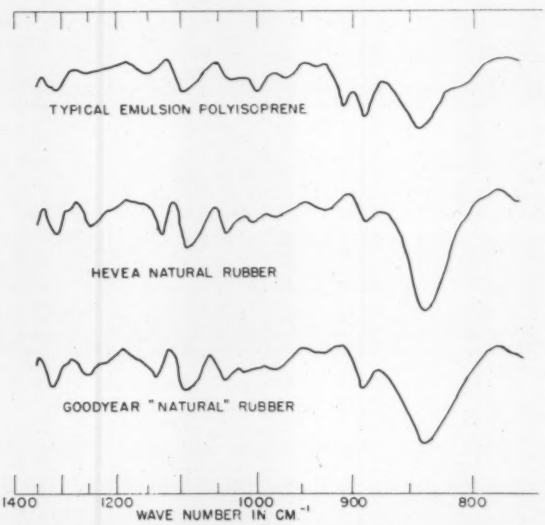

Fig. 3 Infrared spectrum of conventional emulsion polyisoprene, Hevea natural rubber, and new synthetic "natural rubber"

having a structure very similar to that of Hevea natural rubber by means of a Ziegler-type catalyst (28, 29).

It has been disclosed that the catalyst system used is a solid-surface type similar to that which has been developed primarily for polyethylene. A quite rapid solution polymerization or bulk polymerization of very pure isoprene monomer is apparently attained with little difficulty. This catalyst system, which is similar to the one published in the latter half of 1954 by Prof. Karl Ziegler, of the Max Planck Institute for Coal Research in Germany, produces nearly all cis-1,4-polyisoprene. The infrared spectrum is very different in certain key

regions from that obtained on conventional emulsion polyisoprene, and is nearly identical with that of natural rubber, Fig. 3. The x-ray pattern also shows a close similarity to the natural product, Fig. 4. The catalyst is made by combining aluminum triethyl with a cocatalyst under conditions which appear to be quite critical, producing a solid suspension the surface of which is believed to provide the active sites for polymerization.

The progress of the evaluation of this development is still not sufficient to be able to state just how closely the physical properties and performance of this new polyisoprene would duplicate the natural product. However, it is believed that the molecular structures of the two are so alike that the principal properties of natural rubber, which make it preferred over GR-S in such uses as heavy-duty truck tires, would be preserved.

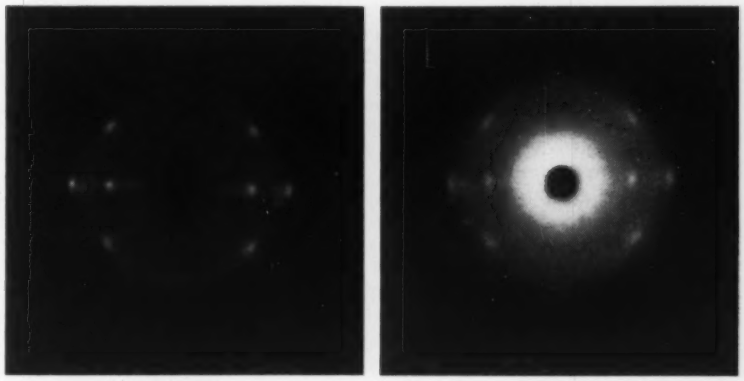

Fig. 4 At the left is shown an x ray of natural rubber compared with polyisoprene rubber at right

It should be noted that although the catalyst system of Firestone (alkali metal) and that of Goodyear (Ziegler-type) differ greatly, still, each results in essentially the same microstructure. It is possible that the principal feature they have in common is the presence of a solid surface. This raises the question as to whether surfaces of high specificity for adsorption of monomer in some particular way play a more important role in determining polymer structure than the mechanism of initiation (28, 29).

Sale of Government Synthetic Plants

Another important event in the rubber industry this past year has been the sale of the government plants which was completed on April 29, 1955. Twenty-four of the twenty-seven plants were sold by that date and one plant was leased for three years (30, 31). Bids were reopened for the Baytown, Texas, plant and it was sold July 15 (32). The success of its sale prodded Congress to reopen bids for the plant at Institute, West Va., with the deadline set at October 7 (33). The Rubber Producing Facilities Disposal Commission accomplished what is considered an exceptionally good job because contract sales prices, less current assets, represent a return to the people of 96.6 per cent of the total unrecovered investment (34).

The aggregate tonnage purchased by the "Big Four," 64 per cent of the GR-S capacity recommended for sale, is closely related to their share of consumption. All plants were turned over to the purchasers on a full production basis. The purchasers also bought all the stock on hand to provide sufficient inventory so that the supply to the consumer would not be interrupted. The new proprietors even have a guaranteed market among some 800 rubber firms who had been on the government customers list (35, 36).

Laboratory to Continue. Among the recommendations in the Disposal Commission's report was that the government laboratory, operated by the University of Akron, should be continued as it is, but under the supervision of the National Science Foundation. More recently a special commission of eleven scientists, educators, attorneys, and other experts has been appointed to study plans for the future of government research. They must decide whether defense rubber needs warrant continuing federally financed research after June, 1956. Key-defense needs include a new synthetic capable of withstanding truck-tire wear and rubber for use at 1000 F in jet aircraft and in subzero temperatures on arctic maneuvers. Nearly half the funds allotted to the university, and other basic rubber research projects, is being spent on the synthetic truck-tire problem. If private companies have the answer, as indicated by the recent duplication of natural rubber, need for continued federal operation of the government laboratories may diminish considerably (37, 38, 39).

Radiation Studies

Last year there was some disagreement between American and British scientists as to whether atomic radiation was detrimental or advantageous to rubber (40). Further research has shown that gamma radiation can be used in place of conventional chemical and heat-treating methods to vulcanize both natural and synthetic rubbers. The degree of vulcanization is governed by the intensity of the radiation and also depends upon the type of rubber and the length of the exposure (41, 42, 43).

Many experimental polymers which offer considerable resistance to vulcanization by chemical means may be vulcanized readily by gamma radiation. A specific example is the effective response of an acrylate polymer to irradiation despite the fact that this particular polymer is greatly resistant to chemical vulcanization. Comparative dry-heat-aging data at 350 F between the two types of vulcanizates indicate a complete loss of rubberlike properties of the chemically vulcanized elastomer in 8 hr while the gamma-ray-vulcanized product attained a similar condition in 36 hr. Oil-aging properties at 350 F in synthetic-base diester oil also showed a definite superiority of the irradiated product.

Supporting evidence has shown that polymers of differing chain lengths or those containing the benzene ring in their structure possess varying degrees of resistance to the effect of high-energy radiation. The changes in tensile strength and elongation after increased gamma-ray dosages closely follow those encountered using conventional chemical vulcanization procedures. Compression-set data of nitrile rubbers which have been subjected to irradiation and compared with similar chemically vulcanized Buna N elastomers show that the

compression set after 70 hr at 250 F is considerably less in the case of the irradiated compounds.

Comparative studies of limiting plasticizer extractability by fuel from a nitrile rubber subjected to radiation as compared to a similar chemically vulcanized compound show that there is a decrease in volume swell of the compounds irradiated at dosages of 4×10^7 and 6×10^7 roentgens (44).

Isobutylene units are degraded by radiation while styrene polymers are cross-linked. Although, in the copolymers, the styrene units protect the isobutylene units, irradiation causes degradation to an extent dependent upon the percentage of styrene, then the copolymer cross-links partially into a gel (45).

Synthesis of New Polymers. Radiation also has been applied to the synthesis of new polymers. The advantages offered when gamma radiation is used as an initiating agent are (*a*) initiation can be effected at low temperatures to polymerize heat-sensitive monomers, (*b*) polymerizations can be carried out in the solid state, (*c*) no foreign substances such as catalysts or promoters are added so the polymer is essentially pure, (*d*) molecular-weight control by temperature change can be achieved over a wide range since the initiation step is temperature independent, and (*e*) the polymer formed may have different physical properties since the radiation can attack polymer molecules in a polymerizing system causing branching and cross-linkage and altered molecular–weight distribution (46, 47, 48).

Because of the fact that high polymers are covalent substances the effect of radiation is largely caused by ionization and electronic excitation, resulting in the formation of free radicals. In this way, in addition to vulcanization, chemical reactions are initiated resulting in gas liberation, double bond formation and elimination, degradation, polymerization, and so on. Consequently, many physical properties are changed (49).

When subjected to high-energy radiation, polydimethyl siloxanes can be cross-linked to form insoluble amorphous structures which are transparent and have marked rubberlike properties (50).

Isotopes as Tracers. Another practical application has been the use of isotopes as tracers in studies of automobile tire-tread wear. Geiger-counter measurements on tracks made by tires molded of materials having radioisotope components gave an indication of wear. This method is advantageous in that significant results can be obtained in a much shorter time than that required by conventional methods (47).

From theoretical observations it has been shown that the heat of polymerization is the factor which determines whether the polymer will degrade or cross-link. Those that degrade have lower heats of polymerization than those that cross-link (51). Since cross-linking occurs without the introduction of heat-treatment or the addition of foreign cross-linking agents, it now becomes possible to study the effect of cross-linking on the physical properties of polymers which have well-defined degrees of linking. The formation of gel in many polymers offers a possible method of obtaining information as to the initial molecular-weight distribution (52).

"Anti-Rads." Understanding the deleterious effects has already resulted in the development of high polymers that will withstand intense radiation (49). Along with the development of special polymers is the discovery of materials called Anti-Rads, which can be added to rubber stocks before vulcanization. They appear to help resist the effects of radiation similar to the way antioxidants allow stocks to resist the degrading effect of oxygen (53).

Tires

The most colorful news this year deals with tires—more specifically, blue, green, and brown tires. Tires appeared on the market early this spring with these colors extending from the outer edge of the white wall to the top edge of the tread. The tread itself is still black to maintain its wearing qualities. The color is accented by the white side wall and by a thin, similarly colored metallic trim between the side wall and the hub. The colored swathe is a 50-50 blend of Neoprene and natural rubber. These three colors were chosen because they can be used with the majority of car colors on the road today, but if the idea meets with public acceptance, other colors may be added (54, 55).

Colored Side Walls. For those who desire color without buying new tires, colored side walls are available in the form of a molded rubber ring which fits firmly between the tire head and the wheel rim so that it looks like the original side wall. They are packaged in sets of four and made in red, yellow, blue, green, pink, and white (56).

Since "style" has been able to dictate color in tires, it is now seeking to give automobiles a still "lower look" with a 14-in. tire. While reducing the diameter of the tire an inch, the size of the cross section will be slightly increased. Work on the new molds is under way, but tire and automotive engineers still have their problems—smaller tire means smaller wheel—means less braking surface. If the problems are solved, the tires probably will appear on 1957 cars (57).

Reinforced Tires. A new line of passenger-car and truck tires will contain from 1 to 8 miles of flexible, high-strength steel wire. The steel wire is intended to make the tire tread ruptureproof, doubles cut resistance, and eliminates tread cut growth. Although tire engineers have been experimenting with the idea for more than 20 years, this is the first time wire has been used successfully. Other tires have been made using wire instead of textiles, but this line is using wire in addition to textiles. The wire is used in filaments which are slightly larger than human hair, then twisted and crisscrossed to give the effect of a fine-mesh steel cloth. The wire is embedded at the base of the tread to protect the carcass and also help to weld the tire tread and carcass together as a permanent unit (58).

Medium-Size Truck Tires. Medium-size truck tires have been developed, containing 35 per cent synthetic rubber, which equal in performance tires made of natural rubber alone. Above 35 per cent, the advantages of natural rubber increase as the advantages of the synthetic decrease. Truck tires of high neoprene content run cooler than corresponding natural-rubber tires, but fail at low mileages because of tread and ply separation. Sodium-catalyzed synthetic rubber gives more durability than low-temperature synthetic rubber. Improvements must be made in hysteresis and in resistance to separation before synthetic rubber can be used successfully in truck tires (59).

An experimental study of the action of centrifugal forces generated in the curves and the effect of lateral winds on tires has been made. By a specifically designed testing machine, the character of the path on which the

tire is rolling can be modified to reproduce conditions corresponding to rough, moderately smooth, very smooth, dry, or wet surfaces. Results of laboratory tests and road tests are in good agreement, and it is possible to draw useful conclusions for both tiremakers and road builders (60).

Road-Testing Programs. In road-testing programs the use of two-way treads is five times more satisfactory than the use of whole tire treads (61).

The friction between a small rubber-covered wheel and ice has been studied. Soft rubber grips better on wet ice than hard rubber. However, on wet ice and on ice just below the freezing temperature friction was so low that the squeezing down of the rubber under load vitiated results (62). It is necessary to measure the coefficient of friction accurately between tire and road surface in order to design tires which will have the highest resistance to skidding under the worst conditions, such as dry or wet ice. An indoor testing machine has been developed to measure the sliding forces and to calculate the coefficient of friction (63).

Rubber in Roads

Asphalt has been used as a paving compound for several years because it provides a stable, nonskid, hard surface, which waterproofs the grade beneath it and resists the abrasion of traffic. However, the increased flow of traffic in recent years, in addition to new applications such as airfield strips, has required improvement in the asphalt properties. It was known that certain synthetic rubbers modify and improve asphalts to a marked degree, but high dispersion is necessary to accomplish the desired results. Therefore a vehicle of some type was needed which would aid dispersion of the rubber and also overcome the tackiness of the raw rubber prior to its incorporation in the asphalt. Research has shown that barytes, an organophilic material, is fitted for these requirements. Photomicrographic studies show that when the barytes-rubber particle is introduced into the hot asphalt the barytes particle migrates into the asphalt, seeking to be wetted. Since it carries the small rubber particle with it, dispersion of the rubber is aided materially by this action (64, 65).

When a rubber-barytes compound is added to asphalt and tar, it improves the flexibility, impact resistance, temperature stability, and aging characteristics of these bitumens. One of the most important qualities imparted to asphalt by rubber-barytes compounds is toughness; i.e., greater resistance to scour, abrasion, and wear. Barytes, itself, reduces stripping. The compounds also improve low-temperature flexibility and cold flow. This is important where the paving is subject to temperature extremes (65).

Technique of Blending. The character of rubber-asphalt blends is dependent upon the type and amount of rubber used, the nature and source of the asphalt, and the temperature, time of heating, and amount of stirring in the preparation of the blends. One investigation has shown that mixtures with preblended rubber are much more compactible and stable than mixtures in which the rubber is added as a powder (66, 67). When a specially prepared GR-S rubber is used (75/25 butadiene/-styrene prepared by coagulation in the presence of a resin polymer or soap detackifier) large changes in the characteristics of the asphalt are produced. This rubber is mainly used when the rubber-asphalt mixture is to be used for highways (66). This mixture is also suitable for airfield strips where it is subject only to high-octane gasoline which evaporates rapidly. However, jet fuel evaporates slowly and will remain on the surface long enough to dissolve some of the asphalt. Therefore oil-resistant rubber, such as butadiene/acrylonitrile, is being used in place of GR-S in the rubber-asphalt mixtures to offer more resistance to any jet fuel which may be spilled (68).

The addition of latex to asphalt has also shown definite advantages in obtaining a durable seal. The combination is effected by a dual-spray technique in which pressure feed may be superior to pump feed (69).

Since the addition of rubber improves the important properties of bitumens and tends to make asphalts from different sources more uniform in quality, better pavements, of greater durability, at lower cost, are available (65).

Seals

Although O-rings have proved their value in numerous applications, they have failed in others. A new type of industrial seal, called Quad-rings, is proving its superiority in these applications. Less squeeze is required for a perfect seal and this results in longer life owing to reduced breakaway and drag resistance. Production performances and field tests have shown no parting line on sealing edges, no torque leakage at low pressure differentials, no spiral twist failures, and no rolling with pulsating pressure. It is a successful rotary seal and dust seal. It also provides a perfect seal for static installations, especially for low pressure as well as extremely high pressures and vacuum (70).

Sealing Low-Temperature Fluids. Sealing low-temperature fluids such as liquid oxygen at high pressures presents another problem. Rubber O-rings cannot be used because they become stiff at low temperatures and shrink away from the groove walls, losing the initial seal. A satisfactory self-sealing seal has been developed which consists of rubber molded onto a metal insert ring having lower thermal contraction than the flange metal, thus compensating for the relatively high thermal contraction of the rubber. Neoprene compounds have been used in most of the tests with this seal. Gasket stresses increase as the temperature is lowered and may be established independently from the clamping means used in assembly of the coupling (71).

Synthetic and Rubberlike Products

Arousing quite a bit of interest this year are polyurethane products. The biggest present application is in the field of foams. The reaction between diisocyanates and polyfunctional resins is initiated by water, producing carbon dioxide, which is the foaming agent. The density of the foam is governed by the amount of water which is added because the water limits the amount of carbon dioxide evolved (72–76). If a low-weight polyol is used to make foam, the polymer is highly condensed and cross-linked and the foam is of a plastic nature. If high molecular-weight glycols are used, the products are resilient foams, usually open cell, having high tensile strength, excellent abrasion resistance, and resistance to tearing (73). Since the preparation of polyurethane foams is an exothermic reaction, curing is not required.

Precautions must be taken against the semitoxic properties of diisocyanates (78).

Foam Products. During foaming, the mass is an excellent adhesive and adheres firmly to anything with which it comes in contact. This permits production of panels having good structural rigidity, excellent sound and thermal insulating properties, and lightweight (72, 73). This adhesive property also can be utilized to make automotive seat cushion toppings, rug and upholstery backing, and other composite articles (78). Other applications of urethane foams include sponges, packaging, wearing apparel, cushioning, and thermal and acoustical insulation. Aside from the properties already mentioned, urethane foams (also known as polyurethane foam, isocyanate foam, and polyester foam) are noncombustible, nonconductive, have excellent ozone resistance, resist moisture, have high strength with low density, and do not become brittle down to —60 F. The polyurethane foam has a much higher compression-density ratio as compared to latex-rubber and vinyl foam and it may be varied greatly by changing the proportions of the chemicals used (72, 76, 77, 78, 79, 80).

Urethane Rubber. Another polyurethane product still in the experimental stage is urethane rubber. This product shows unusual abrasion resistance and is being developed for use in tires. A tire recapped with an experimental product called Adiprene B showed approximately half the rate of wear of a first-line GR-S treaded tire of the same size and design (72, 81). Although urethane rubbers are strong, resilient, have high modulus and hardness, good resistance to ozone and general weathering, excellent oil resistance, and fair resistance to dry heat, they break down rapidly under moist heat and have poor resistance to aromatics, chlorinated hydrocarbons, ketones, substituted ammonium compounds, terpenes, acids, and bases. The compounded rubbers have little or no building tack and poor adhesive qualities (72,82). Since polyurethane rubbers have high heat build-up, a practical tire could not be made of this material alone. Therefore it seems a suitable bonding agent is all that is needed to make the 100,000-mile tread dream come true (83).

Other diisocyanate-polyurethane products may be used as adhesives, gaskets, industrial filters, fibers, and surface coatings (80, 81, 84, 85, 86).

Graft polymers of styrene and methyl methacrylate with natural rubber can be compounded and cured to give light-colored articles of good tensile strength. Rubber-methyl methacrylate graft polymers also have outstanding flex-cracking and fatigue resistance (87).

Oil-Resistant Rubbers. Several studies have been made to find the rubber polymers or copolymers with the best balance between oil resistance at room temperature and low-temperature properties. In making oil-resistant rubbers based on butadiene and acrylonitrile it was found that increased acrylonitrile content improves the oil resistance, but adversely affects other properties such as elasticity, hysteresis, compression set, and low-temperature flexibility. This means that the oil resistance cannot be improved without sacrifice of low-temperature flexibility, and vice versa. A decrease in oil swelling is observed among blends of butadiene-acrylonitrile polymers and natural rubber, probably due to a high state of cure of the blends (88). Butadiene was copolymerized with 1-monochloro-2,2-difluoroethylene and with 1,1-dichloro-2,2-difluoroethylene but little improvement in oil and solvent resistance was shown in comparison to the GR-S control (89). Copolymers of butadiene and 2-methyl-5-vinylpyridine have been compounded with conventional rubber curatives and pigments plus a quaternizing agent, such as an organic halide, to give quaternized rubbers which are resistant to a wide range of solvents including water, alcohols, aldehydes, ketones, dicarboxylic-acid esters, and phosphate esters as well as aromatic and aliphatic hydrocarbons (90). Alfin-catalyzed polybutadiene shows good oil resistance and low-temperature properties, but it is difficult to compound and mix in conventional equipment (91). The best balance between oil resistance and low-temperature flexibility has been found in a butadiene-allyl alcohol copolymer. However, this material requires indirect preparation, since allyl alcohol is a polymerization inhibitor for butadiene (92).

Fluorohydrocarbon Elastomer. Kel-F is a saturated fluorohydrocarbon elastomer which contains more than 50 per cent fluorine. Vulcanization can be achieved by organic peroxides, strongly basic primary and secondary aliphatic polyamines, or a variety of isocyanate-amine combinations. Recommended fillers are precipitated silicas and metal silicates. Kel-F vulcanizates are characterized by good elasticity and tensile strength, by resistance to oxidizing agents such as fuming nitric acid, ozone, oleum, and 90 per cent hydrogen peroxide, and by its low water absorption, its incombustibility, and its stability up to 400 F. Kel-F is compatible with various elastomers and can be vulcanized with them (93–95).

Silicone Rubber. Although silicone rubber was first offered commercially 10 years ago, new developments and applications still make this subject news (96). Rubbers can be made which are flexible below —100 F and that will withstand service as high as 600 F (97). Silicones are water-repellent, heat-resistant, and silicone fluids have small change in viscosity with a change of temperature (98). Although tensile strengths of silicone-rubber vulcanizates are low, they are relatively constant through a wide temperature range. After 4 weeks' aging at 125 C, the tensile strengths of silicone rubbers were found superior to those of chloroprene, butadiene-acrylonitrile, and Butyl vulcanizates (99).

A recent development has provided a silicone rubber which is capable of remaining flexible at 600 F for 150 hr or longer, and this has been done without the sacrifice of any of the other outstanding silicone-rubber properties. Possible applications for this new material include kitchen oven-door seals and parts for hot materials-handling equipment in the glass, ceramics, and metals industries (100).

Good electrical properties with excellent ozone resistance are obtainable, making silicones suitable for electrical insulation where the unique thermal and moisture-resistant properties are also required (97, 101). Electrical designers have been able to achieve 30 per cent savings in weight and space by using silicones, and the moisture-resistant properties also increase the reliability of the equipment (101, 102).

Rubber companies have found that the use of silicone release agents is advantageous because they are nonadhesive, and they do not carbonize on mold surfaces (103). Silicone resins are being used as fabric coatings to impart durable water repellency, resistance to water-borne stains, increased tear strength and abrasion resistance, improved sewability, and recovery from wrinkling (104). Silicones are finding increasing applications in the protective-coatings industry also. Heat-resist-

ant, heat-and-corrosion-resistant, and weather-resistant coatings are being used for painting structures like smokestacks, automotive and aircraft exhaust equipment, stoves, furnaces, space heaters, and incinerators (105).

Composition of Silicone Rubbers. Silicone rubbers are composed of four ingredients: polymers, fillers, additives and vulcanizing agents. Variations in the types and amounts of these ingredients give the rubbers a wide range of properties. The polymer determines the handling characteristics, thermal stability, and low temperature behavior, as well as corona, ozone, and weather resistance, the adhesiveness to organic materials, the solvent and oil resistance, and the vulcanizing ability of the compound. The type and amount of filler used determine the electrical and physical properties. Additives control color, lower compression set, and improve heat stability. The vulcanizing agent reacts with the methyl groups on adjacent polymer chains to cause cross-linking (96, 106, 107). When alkoxy-coated silica filler is used, it has been found that antioxidants decrease the excessive cross-linking of the rubber and retard the tendency to overcure. The molecular weight of the silicone rubber used under these conditions should exceed 400,000 in order to provide high tensile-strength vulcanizates (108).

More recently, silicone rubber has been successfully cured using carbon-black fillers instead of the conventional silica-type fillers. This gives essentially a new product with many new applications. An example is molded conductive silicone rubber usable at temperatures above and below the limits of organic rubbers (109).

In Tires. The first tire in which silicone rubber and glass fibers have been successfully combined will withstand temperatures from —90 to 500 F, far below and above the limits of materials commonly used in tire construction. These tires are especially suitable for high-speed supersonic aircraft where the tires may be exposed to temperatures in the 400 and 500 F range (110).

Principal disadvantages of the silicones are incompatibility with many other substances, some processing difficulties, and relatively poor strength and extensibility (111). The problem of low tear resistance now seems to have been overcome by the development of Teflon-reinforced silicone rubber. This modified product has tear strength three to four times that of regular grades of silicone rubber. The compound is more difficult to mold and the oil resistance is improved, but other properties are not appreciably affected (112).

Butyl-Rubber Compounds. Until recently the supply of Butyl rubber compounds has been limited and consequently there had been no thorough investigation of their properties. However, recent investigations have shown that since Butyl compounds are not readily attacked by oxygen, ozone, strong mineral acids, alkalies, animal fats, and vegetable oils, and since they are also heat, steam, and water-resistant, and show good electrical properties, these properties make Butyl rubber a valuable tool for corrosion control (113, 114). The greatest disadvantage of Butyl rubber is its susceptibility to contamination by other rubber stocks or unsaturated materials (115). Since properties of Butyl reclaim more nearly approach the properties of the mix than any of the other elastomers, it is now being accepted as standard raw material (116). A major disadvantage at present is that staining antioxidants are used in the compounding of Butyl rubber and this limits the use of the rubbers to applications where staining and discoloration are not important. Staining can be reduced by the use of alkaline materials, but when Butyl is used for tubes, this slows up the tubing rate (117, 115). When Butyl rubber was first used to make tire inner tubes, the major deficiency was its tendency to stiffen at temperatures of —10 F and lower. The tubes did not recover as fast as the casing, and wrinkles (or cold buckles) were formed which would rub together and cause failure. The use of substantial proportions of mineral oil, high-temperature cures, and proper choice of black in the stock helped to overcome this deficiency (118).

Modified Butyl Rubber. Butyl rubber may be modified by attaching bromine to the polymer chain. This reaction is one of addition to the double bonds and lowers the unsaturation of the rubber. Both sulphur and metal oxide can serve as vulcanizing agents for the brominated Butyl, and when both are used together, the curing rate is faster than that of Butyl. The properties of these modified polymers can be varied according to the amount of bromine added. However, there is an optimum range of halogen concentration for best results. This optimum range depends on the unsaturation of the original rubber and the end use for which the modified rubber is intended. Since the brominated Butyl can be covulcanized with natural rubber and GR-S, it is now possible to impart to these rubbers the excellent properties of Butyl, such as low air diffusion and resistance to ozone and flex cracking. Other advantages include higher modulus and good adhesion to other elastomers and metals (119).

Compounding

Heat-treatment of reinforcing and semireinforcing carbon blacks over a temperature range of 1000 to 2700 C results in the removal of combined hydrogen and oxygen up to 1500 C, followed by an increasing degree of graphitization at higher temperatures. When compounded with natural rubber, these carbons display a change in properties to varying degrees. The modulus is decreased as the heat is increased owing to the loss of surface hydrogen. The electrical conductivity increases with an increase in carbon-to-carbon contacts, and is thus improved with the removal of volatile matter. Since the abrasion resistance and the tensile strength are determined by the particle size of the carbon black, heat-treatment does not affect these properties (120)

Porous blacks of high surface area can be produced without changing particle size by air oxidation of the raw material. Increased porosity can cause reduction in rate of cure of the black-rubber compounds as well as decreased resilience and electrical resistivity. Reinforcement increases with increasing surface area (121).

Other agents may be used in addition to carbon black to reinforce rubber compounds. Although tire treads containing only amorphous, fine-particle-size, hydrated silica are inferior to the best carbon-black treads, tire treads containing a mixture of carbon black and this type of silica exhibit wear properties closer to those of all-black compounds than would be expected. Compounds containing the mixture also possess greater resistance to hand tear than is shown by all-black compounds. Therefore the use of carbon black-silica mixture may possibly result in improved tires for off-the-road service (122, 123). Tire treads also show good performance when reinforced with 20 to 25 per cent aniline resin (124). It is possible to obtain products that take

complicated molds and have good mechanical properties after vulcanization by replacing varying amounts of the new rubber with crumb rubber before vulcanization. The percentage of crumb rubber in the mixture must be determined by each manufacturer to suit his particular product (125).

Testing

At present there is no best method for determining modulus at low temperatures, and application of the term to rubberlike materials is vague unless the method of measuring is specified. Work is being done to correlate the various methods used with the ultimate aim toward standardization (126, 127). Hardness is defined as the measure of resistance to indentation, and attempts are being made to find the best method of this test. Spring-actuated instruments are desirable in that instantaneous readings are possible, and the Material Laboratory indentometer is presently the most satisfactory dead-weight instrument for low-temperature testing (128).

Compression Stress-Relaxation. The Material Laboratory also has a compression stress-relaxation apparatus for measuring the compression set of vulcanized rubber at constant deformation. The important feature of this apparatus is an electrical means to indicate when the back force of the compressed specimen is equal to the external load applied by the load-measuring device. There is good reproducibility of data (129, 130). The energy loss for a cycle of loading and unloading has been shown to depend on the rates of straining and unstraining as well as on any elapsed time between the straining and unstraining (131). Decay of stress to zero stress followed by spontaneous elongation occurs in samples of stretched unvulcanized natural rubber in the temperature region of crystallization, and indicates that measurement of stress decay at constant extension provides a sensitive method for following the crystallization of both unvulcanized and vulcanized polymers (132).

A machine has been constructed to study the fatigue of flex life of rubber compounds subjected to biaxial strains of controlled amplitude and phase relations, thus providing a means for selecting an optimum cure range for the desired flex life of a polymer (133).

The resistance of conducting rubber is strongly influenced by even very small mechanical stresses, and after stress relief, the recovery to the original resistance value is very slow. Full recovery after relief is indicated by a homogeneous resistance distribution throughout the material (134).

Surface Heating. Under severe conditions, the surface heating which occurs at the interface of rubber sliding under a load may be part of the mechanism of abrasion. Removal of rubber by thermal degradation and a smearing process occurs if the rubber attains sufficiently high localized temperatures. A procedure, using a melting-point bar, has been developed to measure the temperature at which smearing of rubber vulcanizates occurs (135). All rubbers are subjected to the same abrasion mechanism, irrespective of the polymer and filler. Abrasion is proportional to the normal load, independent of the particle size if the abrasive particles are polyhedral, and proportional to their mean radius of curvature if they can be approximated to hemispheres (136). It has been suggested that a correlation may exist between abrasion and high-temperature flexibility properties of the rubber. One underlying principle, that of constant rate of energy dissipation at the abrading surface, has been proposed as a criterion for comparing the validity of test design for the various types of laboratory test currently in use (137).

Tire-Tread Tests. Tests of a tire-tread type GR-S vulcanizate proved that crazing, formerly attributed solely to light-activated oxidation, can be caused by exposure of a biaxially stressed vulcanizate to ozone in the absence of light. The vulcanizate was subjected to different degrees of biaxial stress and exposed to ozone at 100 F in darkness. Microscopic studies of the surface changes showed the crazing was identical with that of tire side walls in service (138). An ozone chamber has been developed which is expected to be a valuable aid in learning more about the effects of ozone upon basic products (139).

A simple method for determining the amount of ozone in the air also has been developed. The apparatus is based on the formation of cracks in rubber subjected to strain (140). It has been suggested that, since compressed rubber is not appreciably affected by ozone, precompression may be a means to prevent degradation. Swelling of the surface of the rubber has been proposed, as well as coating the material with a resistant surface layer, such as Neoprene (141). The rate of change in viscosity of polymeric solutions has been utilized in a method to evaluate inhibitors of ozone-induced degradation. The method is uncomplicated by compounding and processing variables, and provides a simple, rapid, and reliable means for screening large numbers of chemicals for suitability as antiozidants (142).

Useful data on the way in which oxygen tends to combine with rubber may be obtained by measuring the dielectric properties at radio frequencies. Although the polarity of oxidation products may be evaluated with high accuracy, the methods and devices required are too delicate for use as a practical aging test of vulcanizates (143). Structural changes resulting from oxidation have been studied in a number of unvulcanized purified polymers by infrared absorption spectra. Results showed that the structural changes which were detected as oxidation progressed, were qualitatively the same for all of the polymers studied (144).

Infrared Spectroscope. Infrared spectroscopy can also be used to determine the total unsaturation of emulsion polymers as well as the amounts of cis-1,4, trans-1,4, and 1,2 addition in polybutadienes and the amount of styrene in butadiene-styrene copolymers. It is also possible, by this method, to obtain quantitative information about the effect of polymerization variables on the microstructures of diene copolymers (145).

The Mooney Viscometer. The Mooney viscometer has been such a valuable tool for measuring polymers, it has been standardized and universally applied in synthetic-rubber manufacture and use. Although it is an excellent measure of plasticity for polymers of low ratings, it is unreliable in the upper range. In order to take advantage of the resilient and abrasion-resistant qualities of high molecular polymers, the Olsen flow test has been developed for measuring the plasticity of polymers in the upper range. This test permits the selection of material for good adhesion to tire cords. There is correlation among adhesion strength, Olsen flow plasticity, and the quantity of mercaptan modifier used in making polymers with good adhesion to nylon and rayon (146).

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Briefing the Record

Abstracts and Comments Based on Current Periodicals and Events

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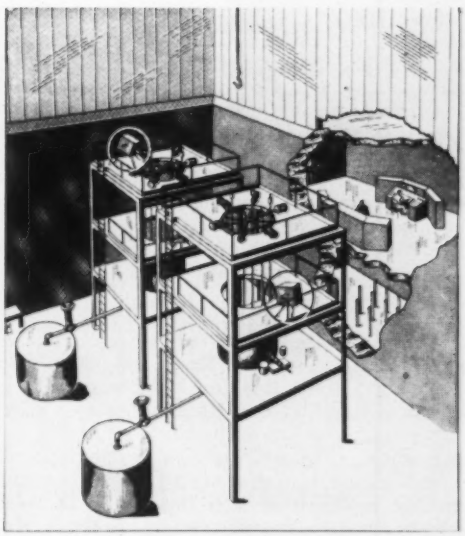


Battelle Institute has just completed a reactor development (critical assembly) laboratory for use in full-scale model studies of nuclear-reactor cores for power production. Such studies, carried out at one to two watts power (zero power) are needed in order to make final design determinations for the operating reactor. The control panel shown in photo (*left*) was designed and built by Battelle engineers and contains all the controls used for a full-scale reactor. The reactor room in the sketch (*right*) shows two "critical assembly" mock-ups for the experiments to determine how final power reactor cores should be designed and constructed. Closed-circuit television cameras (*circled*) aid in remote operation of the reactor cores from control panels in a shielded room shown in the cutaway section of sketch. A vault under the control room is used to store uranium. Protective 2-ft-thick concrete walls surround the reactor room.

Reactor Development Laboratory

A REACTOR development laboratory—for use by industry and government in the development of reactors for power production and propulsion—has been completed at Battelle Institute, Columbus, Ohio.

The laboratory is the second major unit in Battelle's new Atomic Energy Center and is the first private installation of its kind available for direct research on atomic power plants. It supplements other Battelle facilities used for the study of reactor materials and for the application of atomic energy to industrial uses.

The new unit, a critical-assembly laboratory, currently is being readied for study of problems in connection with the design and construction of reactors for electrical power plants. It will be used also for research on atomic engines for aircraft, ships, and other means of aerial, land, and water transport.

According to Dr. H. R. Nelson, in charge of the Battelle Atomic Research Center, all designs of nuclear reactors must be evaluated in full-scale model form to provide engineers with the information they need to build the operating reactors. In designing nuclear reactors, many decisions can be made on the basis of theory and mathematical computations. There are, however, numerous design factors that can be determined only by experimentation. Battelle's reactor development laboratory will be available to private firms for such experimentation.

In addition to the materials themselves, the geometry, or arrangement in space, of the components of a reactor core is one of the most important determinants of reactor behavior. According to Dr. Nelson, the new laboratory will give research technologists a tool for making the studies of reactor geometry that are needed before final specifications can be established for any individual reactor. It will also be used to work out practical start-up schedules, or in the case of an operating reactor, to evaluate innovations without interrupting the power plant.

The laboratory building contains about 10,000 sq ft of floor space. A room 40 ft sq × 50 ft high, will house the mocked-up nuclear-reactor cores. Adjacent to this room is a vault for storing fissionable material, and shielded from these areas are a control room, instrument repair and machine shops, a radiation counting room, and offices.

The control apparatus for the critical assemblies was

designed and built by Battelle engineers. The panel provides all the controls that would be found in a power-reactor station, and in addition, it is equipped with a number of research circuits. Close-circuit television has been installed, allowing researchers to view the reactor cores while experiments are being performed.

The laboratory's reactor room will provide enough space for mocking-up both solid-fuel and liquid-fuel reactor cores. Ample clearance is provided so that solid-fuel cores can be built with either vertical or horizontal control and regulating rods.

Operation of reactor cores at so-called "zero power," or about 1 to 2 watts, will yield data on fuel requirements, neutron flux, power distribution, and control requirements. At the low power of 1 to 2 watts, no shielding is required, nor is it necessary to put the reactor core in a pressure vessel or to pump coolant through the core. Thus the arrangement of fuel, moderator, control rods, and other variables is flexible and can be changed readily for experimental determination of their optimum arrangement. Nevertheless, the experimental cores mocked-up in the reactor development laboratory will contain all the types of atoms and a full complement of the materials needed for reactor cores capable of being operated at power levels on the order of 200,000 kw.

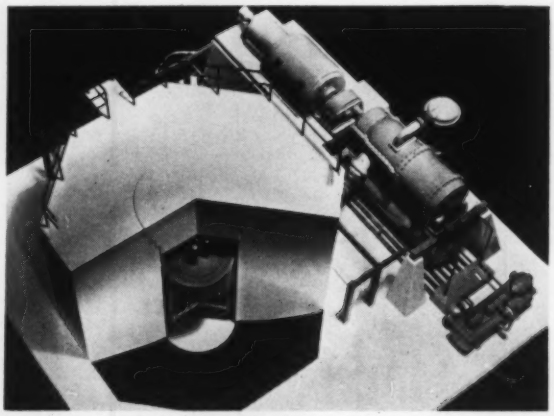
The first unit in Battelle's atomic research center, a hot-cell laboratory, was completed and put in operation in September, 1955. It is now being used in studies on the effects of radiation on reactor construction materials and other studies requiring handling of highly radioactive substances. The third unit, a swimming-pool-type research reactor, is in an advanced stage of construction and will be in operation later this year. The reactor will also be employed in studies related to the development of nuclear plants for generating electricity and as a source of neutrons and gamma rays for use in Battelle's research for the chemical, food-processing, pharmaceutical, metals, machinery, ceramics, electronics, and textile industries.

Combination Atom-Gas Turbine Plant

A 15,000-kw combustion atom-and-gas-turbine power plant, designed to provide competitive nuclear power for homes and businesses within five years, was suggested in a formal offer to construct under the AEC's Power Demonstration Program the nation's first closed-cycle, gas-cooled power reactor. The offer, calling for a facility expected to cost upward of $10 million including research and development, was embodied in a proposal submitted by the Gas and Electric Department of the City of Holyoke, Mass., in conjunction with Ford Instrument Company of Long Island City, N. Y., and Sanderson and Porter Company of New York, N. Y.

Holyoke, one of the biggest producers of high-grade bond and writing paper in the world, is a community of 60,000 population about 10 miles north of Springfield. Holyoke's Gas and Electric Department currently furnishes all domestic and commercial electrical power in the city. The proposed nuclear plant, featuring such advantages as small size and simplicity of design, would supplement the city's conventional power source.

Ford Instrument Company, a Division of Sperry Rand Corporation currently supplying controls for the *Seawolf*, atomic submarine, proposes to design and build the nuclear portion of the plant. Sanderson and Porter, a consulting engineering firm, would design the plant and supervise the construction.



Model of a 2000-kw closed-cycle gas-turbine nuclear-reactor power plant—reactor design by Ford Instrument Company—rotating machinery by American Turbine Corporation in conjunction with Escher Wyss of Zurich, Switzerland. The proposed 15,000-kw nuclear power plant for the city of Holyoke, Mass., is based on design principles of existing fossil fuel-fired equipment of the type illustrated in this photograph.

The proposed nuclear reactor is unique in that it does not require primary-loop heat exchangers. It uses an inert gas, such as nitrogen, to transfer heat from the reactor to the turbomachinery.

By using a closed cycle, the gas discharged from the "exhaust" end of the turbine is captured and recirculated through the system. This will prevent emission of radioactive gases into the atmosphere and prevent possible damage to the reactor caused by oxidants in the air. Also, the objectionable noise generally associated with gas turbines will be substantially reduced.

The two-stage compressor of the turbine unit compresses the gas, sends it to the reactor to be heated, and then through a duct to the turbine. The gas drives the turbine which, in turn, drives the electric generator. The gas then is cooled and returned to the compressor.

The reactor, fueled with slightly enriched uranium, would heat the gas to approximately 1300 F. The design, employing a relatively new concept, is expected to result in high cycle efficiency both at full and part load as well as contribute materially toward the goal of competitively priced nuclear power.

The proposal also provides an alternate means of heating the gas with conventional fuels and thus offers for the first time an opportunity to compare both types of operations as well as produce useful power before the reactor can be built and during periods of reactor shutdown.

Nuclear Fusion

CONTROLLED nuclear fusion will be very difficult to achieve, according to the *Industrial Bulletin* of Arthur D. Little, Inc., for February, 1956. Foremost among the problems to be solved appears the need to sustain and contain temperatures over a million degrees, equivalent to those of the sun. Research on this, in the United States, is being carried out within the framework of the Atomic Energy Commission's Project Sherwood.

In the fission process, one deals with heavy and

inherently unstable nuclei, for example those of uranium 235 or plutonium 239, that consist of many protons and neutrons. When such nuclei fission, through bombardment by neutrons, energy is released—principally in the form of heat energy of motion of the fission products. In addition, more neutrons are released, and under proper conditions they can react with other nuclei to sustain a chain reaction that can be controlled for peaceful purposes—power generation or propulsion.

The fusion process, however, deals with very light nuclei, such as those of the various isotopes, or forms, of hydrogen. The problem is to bring them close enough together so that they will merge, or fuse, to form a heavier nucleus, plus energy. Unfortunately, there are very strong repelling forces between nuclei, since they are electrically charged. But if accelerated to very high speeds, for example by raising them to high temperatures, the nuclei may come close enough to interact. The current aim is to produce appropriate environments by developing high enough atomic velocities (analogous to temperatures) and to sustain the fusion reaction in a controlled way.

In a hydrogen bomb, a nuclear-fission explosion produces the high temperatures required, but this is obviously impractical as a means of controlled power generation, the *Bulletin* notes. We know that at high temperatures all matter is gaseous and "ionized," i.e., the nuclei are stripped of some of their electrons; such an ionized gas—called a plasma—is familiar in neon tubes, and can be suspended free of confining walls by electrical and magnetic forces. One suggestion for controlled fission is to raise the temperature of a plasma by passing it into high-energy particles from a "linear accelerator." But to quote Dr. Henry DeWolf Smyth, a former AEC Commissioner: "We know of no trick way to produce (controlled) nuclear fusion reactions."

One reason cited for the great interest in fusion, it is pointed out, is the relative abundance and low cost of the raw materials—e.g., hydrogen in its heavy forms, obtainable from sea water, or lithium, which is ten times more plentiful than uranium. But the fusion reaction has by no means been decided upon; the AEC gives three potential examples, none involving lithium directly, although lithium is a possible "raw material" source for tritium—the heaviest form of hydrogen. Speculation in raw materials, therefore, on the basis of information available today, is premature. Admiral Strauss, AEC chairman, reports his belief that "every dollar that is invested in an atomic fission reactor will have been amortized long before fusion is either found to be feasible or infeasible."

It is frequently pointed out that since the fusion reaction does not generate radioactive waste products, it will be inherently safer to operate than the fission reaction. There may also be less penetrating radiation; therefore less shielding might be needed than in a fission plant. But some problems would remain. If the heaviest isotope of hydrogen (tritium or hydrogen-3) were used as a raw material, the handling problem would be acute, since tritium is still exceedingly toxic, although less so than plutonium, used in fission reactors. In any event, the argument is almost trivial in comparison with the technical difficulties to be overcome to achieve controlled fusion at all.

Recently there has been some popular confusion as to the suitability of various raw materials for either the fusion or fission reaction. In part, this is because of reports of the "fission-fusion-fission" bomb that uses uranium-238, a very heavy element. Actually, however, the U-238 in this bomb fissions, but only if a fusion process produces beforehand the high-temperature environment required. It turns out that energy-releasing fusion can only be accomplished with the lighter nuclei. Thus the heavier elements—thorium, for example, and uranium—are not candidates for fusion.

If one calculates the energy available from fusion of the light nuclei, the *Bulletin* article concludes, one finds that pound for pound of raw material, fusion is more energy-productive than fission. But one cannot, for this, or any other reason, say "a fusion reactor is better because...." It has taken a decade of applied research—of a very high order of excellence—to bring nuclear power reactors (based on fission) even to the present state of the art, where none is yet operating in this country on an economical basis. Controlled fusion, like the impossible, "will take a little longer."

Atomic-Energy Report

According to the Nineteenth Semiannual Report of the Atomic Energy Commission, the outstanding event of 1955 in connection with atomic-energy development was the International Conference on the Peaceful Uses of Atomic Energy which was held in Geneva, Switzerland, August 8 to 20. Originally proposed by the United States and later sponsored by the United Nations, the Conference brought together scientists and engineers of 73 nations to discuss almost every facet of the subject. There were extensive Governmental and commercial exhibits.

There were many other noteworthy developments in the Atoms-for-Peace program of the United States and co-operating nations during this reporting period. The growing pace of action required the creation of a new Division of International Affairs to provide organizational arrangements to help handle the Commission's part in the program.

Events included completion of co-operative agreements between the United States and 22 other countries on peaceful applications of atomic energy (5 others were pending) as of Dec. 31, 1955; steadily increasing international exchange of technical information on various phases of atomic developments; progress in the establishment of an International Atomic Energy Agency; and announcement by the Commission of a price for enriched uranium leased to co-operating nations under bilateral agreements (along with sales prices for normal uranium and heavy water).

While moving forward with the international Atoms-for-Peace program, the Commission continued its domestic activities at an accelerating pace. The pattern was formed for further AEC provisions to encourage private enterprise in the development of an atomic-energy industry, and for applying the necessary regulations and licensing arrangements under the Atomic Energy Act of 1954.

A constant flow of applications for access permits from a wide variety of industries, trades, and professions testified to the interest of private organizations and individuals in obtaining access to restricted data on civilian uses. An accelerated program of reviewing Commission reports and other papers useful in civilian applications and declassifying or downgrading whenever possible

was entered upon. At the same time the program for publishing material available to industries and individuals in the civilian-application program was greatly stepped up. Seminars and other meetings were held with representatives of companies interested in getting into the processing or production of selected atomic-energy materials.

Domestic uranium ore and concentrate production continued to rise, maintaining this nation's position as one of the world's leading uranium producers. Further foreign expansion in the production will result from the operation of new ore-processing facilities under construction in the Union of South Africa, and in Canada. Increases in domestic ore reserves, on the Colorado Plateau and elsewhere, were again reflected by the greatly expanded exploration activity of private industry. Research and process-development studies on economic methods for recovery of uranium from its ores continued.

Production of various special nuclear materials during the last half of 1955 equaled or exceeded the quantities produced during the first half of that year.

Construction of the gaseous-diffusion facilities at Portsmouth, Ohio, was ahead of schedule as the last building neared completion. Construction of additional feed-materials processing facilities which began last March at Fernald, Ohio, St. Louis, Mo., and Paducah, Ky., is under way.

On Oct. 27, 1955, the Commission announced it would accept up to Oct. 1, 1956, proposals from industrial concerns for the manufacture of uranium feed materials.

Constructive activity continued to be concentrated on production plant facilities. However, with the shift in emphasis to constructing reactors of civilian and military significance, activity in this area is gradually gaining momentum and is expected to become increasingly important in the construction program.

Largely as a result of progress in the construction of plant facilities, capital investment in atomic-energy plant facilities was estimated to have reached about $6.64 billion before depreciation reserves.

Analyses of the results of Operation TEAPOT, the test series conducted at the Nevada Test Site in the spring of 1955, opened up several new and promising avenues for research and development which could strengthen materially the defenses of this nation and the free world. Research and development during the last half of calendar year 1955 proceeded on an expedited basis, both for these new approaches and for those established by earlier study and test.

The Commission's program of developing reactors for industrial and military power and for naval and aircraft propulsion made significant progress. In September the Commission issued its second invitation under the power-demonstration-reactor program for proposals to develop, design, construct, and operate power reactors ranging from 5000 to 40,000 kw of electrical capacity to demonstrate the practical value of such units for commercial use.

Emphasis continued on development of advanced power-reactor technology through a number of experimental reactor projects. In this program four reactors are now under construction, three of which are scheduled to be completed in the calendar year 1956, and the fourth in 1958. Construction of a fifth is scheduled to start in 1956. Also, four new small reactor experiments are under way to explore other promising reactor concepts.

In the field of military-reactor development, the USS *Nautilus*, powered by the Submarine Thermal Reactor, Mark II, steamed more than 25,000 miles and the reactor continued to operate satisfactorily. Development work for a boiling reactor to produce about 200 kw of electricity was begun as part of the Army program. Prospects for nuclear-powered flight continued to show promise.

The Engineering Test Reactor, a major tool for the development of all types of reactors, advanced to the architect-engineering stage. The ETR—in purpose a companion to the Materials Testing Reactor—is to be built next to the MTR at the National Reactor Testing Station.

Substantial progress was made in the construction of the nation's first large-scale (60,000 kw) civilian nuclear power plant—the Pressurized Water Reactor at Shippingport, Pa. Westinghouse Electric Corporation is developing, designing, and fabricating the nuclear portion of the plant and will operate the entire plant upon completion.

The physical research program continued to make significant contributions to fundamental knowledge of atomic energy and related sciences. As a result of these recent accomplishments the horizons for future research have been widened.

Significant progress was made in the use and development of accelerators for research in high-energy physics. The antiproton was discovered as a result of research performed with the bevatron. The 86-in. cyclotron at the Oak Ridge National Laboratory demonstrated that many interesting radioisotopes can be produced economically and in large quantities. The technique of studying magnetic deflection of fine beams of atoms has been so perfected that it has become possible to determine the magnetic properties of the nucleus even for radioactive atoms. A major research effort (Project SHERWOOD) is under way in a long-range program to develop the controlled release of energy from atomic fusion.

Electronically Controlled Drilling Machine

An electronic control system for drilling machines has been developed by Minneapolis-Honeywell Regulator Company. The control system enables an operator to "dial" the X and Y co-ordinates of a desired hole location and to perform any drilling operation by merely pressing a button.

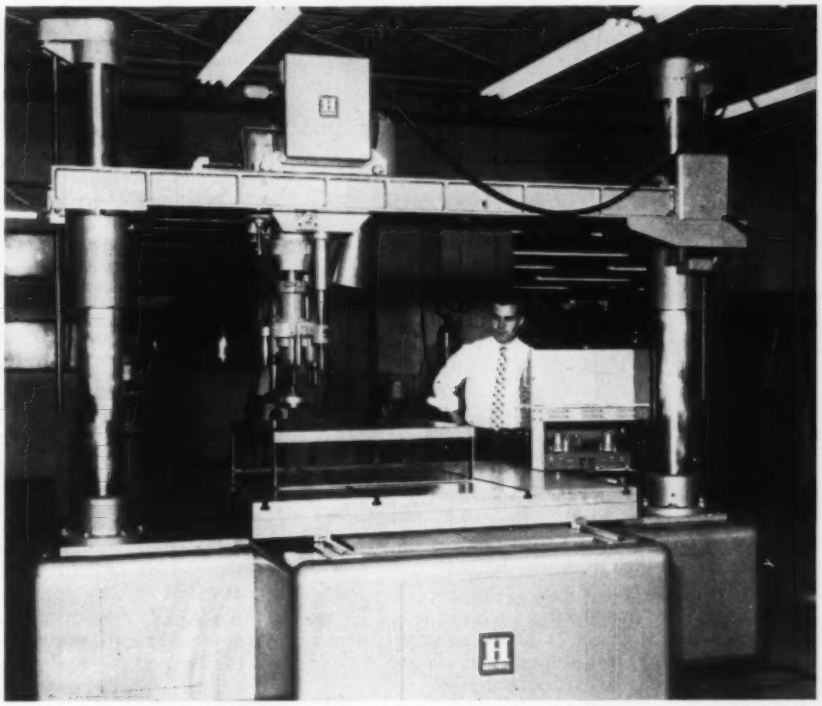
Drilling time per hole is reduced substantially, as it eliminates the traditional process of manually laying-out, checking, center-punching, and hand drilling. The possibility of human error also is minimized.

Honeywell's machine-control engineers designed the control system for a special machine built by Farwell Metal Fabricating Company of St. Paul, Minn. It is currently being used by the company to drill holes for mounting instruments and dials on master panel boards. These will later form the master control centers for industrial control systems, commercial heating, and air-conditioning networks, and other types of automation installations.

The control-equipped machine, M-H engineers explain, is especially suited to the large area of machine-control operations in which automatic numerical control is neither economically justified nor necessary. They point out that control of the drilling machine through punched cards or tape was technically feasible. How-

ever, the added expense would not have improved the machine's productivity to any great extent. The production of such control panels, they explained, is a highly customized business and repeat orders for a specific panel configuration are relatively rare.

Controls and instruments which are mounted on such panels require virtually unlimited combinations of mounting-hole spacing and locations, plus a wide range of hole diameters. The panels may range from small units a few square feet in area, accommodating only a handful of control instruments, to full-size sheets 4 × 8 ft and larger. Some panels are merely flat sheets designed to fit into an open framework. Others are built with integral mounting brackets or legs and must be drilled after fabrication. The material is usually $^1/_8$-in. steel, although $^1/_2$-in. masonite is finding wider application where great strength is not required.



Rear view of automatic drilling machine shows traveling drill head and movable table. Both move 4 ft in perpendicular directions permitting any point in a 4 × 4-ft area to be machined accurately and quickly. Automatic controls permit operator to dial *X* and *Y* co-ordinates and perform drilling operation simply by pressing a button.

The new control system consists of dials with which the operator sets the desired *X* and *Y* co-ordinates. A traveling drill head and movable table permit positioning of the cutting tool over the workpiece. Both can move up to 4 ft perpendicularly permitting any point in a 4 × 4-ft area to be machined. "Step" methods permit handling of larger sheets.

The drill head is equipped with a multiple-spindle attachment. It can simultaneously drill up to five holes of varying dimension, with an accuracy of 0.005 in. A variable-speed motor provides proper spindle speeds for drills as small as $^1/_{32}$ in. Use of a belt reduction permits sawing or fly-cutting of holes up to 6 in. This makes it possible, it was explained, to machine both the clearance hole and mounting holes for a pressure gage or other instrument at one pass. This feature is particularly useful when several identical components are to be mounted on a panel.

The drill head and table are positioned by conventional positional servomechanisms, controlled by dials on the control console. Other controls provide for jogging all machine motions, control of spindle speed, sequence of drilling operations, and permit choice of constant feed or constant thrust drilling. Reset controls are also provided to return the head and workpiece to a location convenient for the operator following single operations. Indicator lights show the position of the head and the table relative to the "called-for" position. They also give the operator a visual indication when the cutting head is in its proper location.

The head and cross-rail assembly can be raised or lowered to accommodate panels of various heights and shapes.

Projectile Research

Dropping and firing bombs and other projectiles into two tanks of water are keeping three Worcester Polytechnic Institute engineers extremely busy.

However, there are no casualties at the Alden Hydraulic Laboratory and hardly a splash of water on the floor.

It is all done with miniature models as part of a research program under contract for the United States Navy.

Leslie J. Hooper, Mem. ASME, laboratory director, says the experiments are to find out how various shapes and designs of projectiles behave when they are dropped or fired into water.

When the WPI findings are combined with research from other centers, it will enable the Navy to design more deadly and accurate weapons of offense and defense.

WPI's part in the program has been carried on over the past 13 years under Navy contracts that average $40,000 annually.

The projectile models at Alden Laboratory range in diameter from $^1/_4$ to $1^1/_4$ in.; in length, from a few inches to 10 in.

The work has been with various shapes of projectiles, which simulate bombs, airplane-dropped depth charges,

torpedoes, and rocket-propelled antisubmarine weapons.

It is conducted in two large tanks of water. In one, tests are made with models that are dropped into the water or fired into it from a carbon-dioxide powered "gun" that propels models at speeds of about 150 fps.

In the other, projectile shapes are fired from a specially designed gun, powered by blank 50-caliber machine-gun cartridges. These models enter the water at 1000 to 1500 fps.

Still and motion pictures are taken of the model's path to show how it behaves when entering water at varying speeds and angles.

What the Navy wants is a projectile that will be stable in its performance under all conditions and follow a similar path each time under the same conditions.

Tactical TV Camera

A HAND-HELD TV camera and back-carried transmitter that a soldier-scout can use to send battle pictures to his command post has been developed by the Signal Corps Engineering Laboratories, Fort Monmouth, N. J. The camera weighs only 8 lb. The transmitter or sending station, complete with built-in power supply, scales 47 lb. See frontispiece, page 308.

By carrying his own battery pack the armed TV roving reporter is freed from the cumbersome cable connections that harnessed him to a source of power and limited his movements afoot as in earlier models.

The Signal Corps TV cameraman can now reach previously inaccessible spots. He can move unhampered through protective forests and hedgerows, and over ditches.

Mission completed, the TV scout can proceed to a new location taking his electronic eye with him.

The voice accompanying the picture could be handled by the Signal Corps handy-talkie radio. In recent field tests at the Fort Monmouth Laboratories, the camera and radio paired efficiently as reconnaissance eyes and ears.

Pictures up to a mile distant can be picked up by the flat cigar-box-shaped camera and sent to a receiver another half-mile away.

The camera has four interchangeable lenses including a wide angle to view a broad sector, and a telephoto for faraway subjects. It has a pistol grip to help steady the camera and "pan" the action.

The Army's camera can also be mounted on a tripod for unattended operation. Surveying the battlefield, it could serve as a silent sentry to watch a road and report enemy movement. With artillery, it could cut heavy forward-observer casualties by replacing them in exposed positions. It also could be used in helicopters to direct air-sea rescue operations.

Likewise, the unmanned camera might be stationed in a suspected radioactive area, unaffected by gamma radiation that would endanger a soldier.

The sending station, which looks like a small suitcase, transmits pictures continuously for two hours. A five-cell rechargeable silver zinc battery, about one third the size and weight of a car battery, is easily replaced in two minutes.

The TV receiver with 10-in. aluminized picture tube is mounted in a jeep for fast mobility. In emergencies, it can be used in a foxhole.

The jeep's electrical system provides all needed power at the receiving point. Commercial power or regular household current also can be tapped.

From the jeep the televised picture could be relayed to higher headquarters, or "piped" into a commercial TV system.

The new Signal Corps camera can also be used with cable between transmitter and receiver. With power

Serving as reconnaissance eyes and ears are the Army Signal Corps new 8-lb tactical television camera, *right,* and the handy-talkie radio

The push-button controls on the console let Army TV Commander monitor video pictures sent by a quintet of TV roving reporters in the field

packaged in the transmitter, cable size is four times smaller than earlier models.

Push-button controls at his jeep console let the TV commander monitor the pictures taken by five cameramen in the field. He can survey a battlefield from different angles, just as a commercial television station covers a baseball game.

This latest TV combat unit was built to Signal Corps specifications by the Radio Corporation of America.

Projection Magnifier

A NEW reading aid that magnifies reading material is now available to people handicapped by poor vision. It is designed to help those who cannot read ordinary books, newspapers, or letters, even with glasses. Known as the Projection Magnifier, this aid for the handicapped is an optical instrument that projects a three or five-times enlarged image of reading material on its built-in illuminated screen, where it can be read easily for prolonged periods at a normal comfortable reading distance.

The Magnifier is the result of five years of research, development, and testing by the staff of The Franklin Institute Laboratories for Research and Development, Philadelphia, Pa., with the support of The W. K. Kellogg Foundation of Battle Creek, Mich. The American Optical Company manufactures the instrument.

The main advantage of the Projection Magnifier is that it makes reading as nearly normal and easy for the visually handicapped as it is for those who have unimpaired sight. It is small, light, and rugged enough to be portable. It adjusts automatically to accommodate reading material of almost any size or thickness. Illumination is provided by one inexpensive 40-watt lamp with an expected life of 1000 hr; burned-out lamps are rare, and burned fingers from lamp heat are virtually impossible.

The primary parts of the Magnifier are the movable upper housing (containing the lamp, lens-and-mirror system, and the screen), and the stationary supporting frame, which also holds a sliding bookrest. The over-all dimensions are $13^1/_2$ in. high $\times$ $13^1/_4$ in. wide $\times$ 22 in. long. The screen is 12 in. wide $\times$ $4^1/_2$ in. high, which means that at three-times magnification a line of print originally $3^5/_8$ in. long will appear within the screen and at five-times a line originally $2^3/_8$ in. long. For example, seven lines of a newspaper column fit on the screen in full width at five-times magnification; a Magnifier with three-times magnification will permit even more material to be seen at once. The reader scans across a wide page simply by sliding the bookrest to the left. He reads down a page by sliding the bookrest away from him. In other words, the reader moves material under the device in the same manner as though he were viewing it through a stationary port or window.

Size of the reading material—even the thickest books—is accounted for in the design of the instrument. By virtue of its parallelogram suspension, the upper housing remains horizontal and flat against the page regardless of the thickness of the book, which helps insure an evenly focused image. To turn a page, the reader pushes up gently on the upper housing (counterloaded to stay in any position), turns the page, and pushes the housing down against the page again. No uncommon movements are needed since the reading material lies

Projection Magnifier designed by The Franklin Institute Laboratories under a grant from The W. K. Kellogg Foundation and adapted by American Optical Company engineers for quantity production

before the reader in the same position as it would if he held it in his lap—right side up.

The screen has a Fresnel lens designed to produce even contrast from edge to edge and to give equal focus at every point. An important advantage of this special illuminated screen is that the room in which the Magnifier is used need not be darkened, as long as a bright light is not directly in front or in back of the user.

Data-Processing System

A CO-ORD:NATED data-processing system, called the "Datamatic 1000," employing high-speed computer principles to speed all phases of record-keeping and accounting, was unveiled recently by Datamatic Corporation, Newton Highlands, Mass.

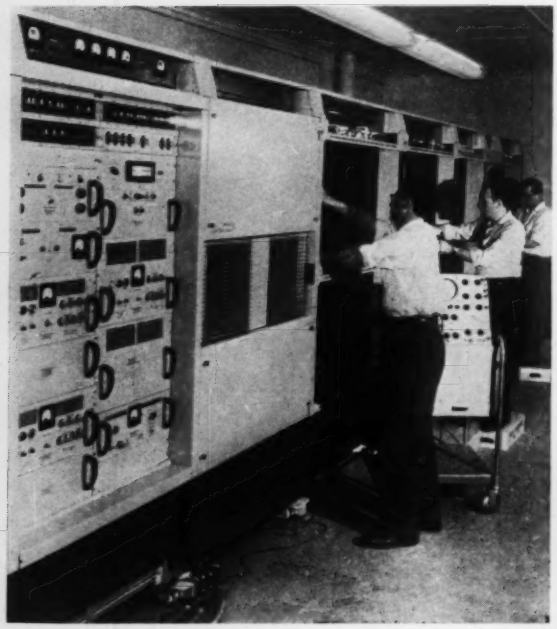
The new system was described as a highly efficient electronic office capable of handling a wide range of clerical operations, from accounting and billing to sales analysis, inventory, and production control. In addition, the system provides management with continuous compiling and processing of reports upon which daily business decisions are made. It is designed for sale to both business and government.

Datamatic Corporation is a jointly owned venture of Minneapolis-Honeywell Regulator Company and Raytheon Manufacturing Company.

Data for the new processing system is fed, in the form of punched cards, into an input converter (a special transcription device) which translates, edits, and transcribes the data onto 3-in-wide magnetic tapes at the rate of 900 cards per min. One reel of tape (2700 ft) can store 37,200,000 decimal digits of information—or the equivalent of information contained on 465,000 punched cards.

The central "brain" can "read" and "write" at the rate of 60,000 digits per sec, simultaneously handling 1000 multiplications, 4000 additions, or 5000 comparisons.

One magnetic tape file unit in the Datamatic system can handle (read, write, or file) as much information as some of the older systems can store altogether. The



Engineers probe innards of new $1.5-million data-processing system to check on the operation of its memory section. This wing is part of a co-ordinated system that constitutes Datamatic Corporation's office automation entry. The panel (*left*) permits operating personnel to keep tabs on power supply.

system's building-block arrangement permits the incorporation of as many as 100 tape units, any one of which can be referred to or questioned without disturbing the rest of the system.

Final reports are turned out at the rate of 6000 punched cards per hour or 900 printed lines of report per minute.

The completed system would sell for $1.5 million up depending upon optional equipment. Rentals range from $30,000 to $40,000 per month.

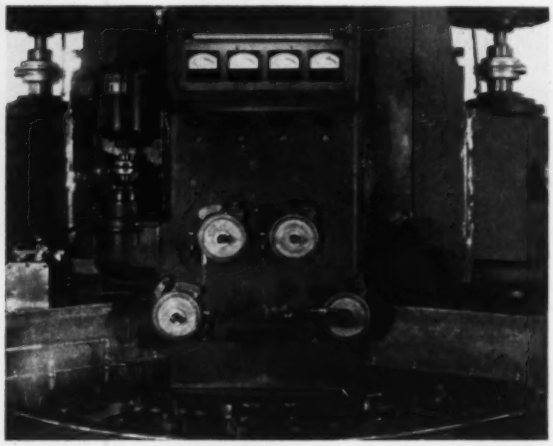
Motor-Load Reading by Ammeters

Motor loads are being closely controlled by use of ammeters. The primary purpose of the use of ammeters on motors is the indication of relative load or loads. Since visible check of actual load conditions on each motor is readily available, the machine operator can change machine setting to maintain optimum loads, without danger of overloading. One make of ammeter has a graduated face ranging from 0 to 150 per cent of load. The section of scale from 125 to 150 per cent is red to indicate overload.

Some ammeters are equipped with an adjustable ratio transformer, which makes them adaptable to almost any motor. This use of ammeters enables a machine manufacturer to set motors for proper work loads operationwise, so eliminating overmotoring. Proper machine feeds and tool speeds are readily determined. When feeds and speeds are constant, the ammeter will tell when tool sharpening is indicated.

Various industries use ammeters where motor load can be connected with quality control, as when batches are mixed which are required to a specific consistency. Surface grinders particularly adapt themselves to the use of ammeters. The ammeter progressively indicates higher motor loads as the wheel grits dull. On multiple-spindle grinders, such as those made by Mattison Machine Works, each spindle is separately powered so the use of ammeters is very valuable in balancing loads.

The same thing is found in the woodworking field, particularly in reference to multiple-drum sanders, like those made by Solem Machine Company. Each drum is separately powered with ammeter reference to each motor. The drum sanding machines in this line are four-drum endless-bed sanders and eight-drum double-



Close-up of working area of multiple-spindle grinder, equipped with fixtures on a large-diameter rotary table, and equipped with four grinding spindles. A row of four ammeters, located at easy reading level, corresponding to the four spindle motors, are in view just above the working area. Photograph courtesy Mattison Machine Works, Rockford, Ill.

View of endless-bed four-drum sander operating in the plant of P. A. Starck Piano Company of Chicago, Ill. Ammeters are located directly adjacent to motors whose working loads they show. An operator can compare working loads on the four directly mounted motors, insuring that each motor is carrying its consistent part of the over-all sanding load. Photograph courtesy Solem Machine Company, Rockford, Ill.

deck machines, the latter making high-production showings where Douglas Fir plywood is sanded both sides at once. These double-deck machines actually incorporate 16 ammeters, 8 of which are visible to the operator while he is making drum adjustments, the remaining 8 while operating.

Undoubtedly industry has lost heavily on many machines where ammeters would have greatly reduced or eliminated such loss. Much of this comes from the fact that operators, in general, do not have a very close understanding of the load they can place and maintain on a motor. In some cases, therefore, an operator has persistently overloaded a motor and burned it out. In other instances, where a motor was not provided with overload protection, timid operators have kept a machine on exceedingly low load, to play it safe.

While motors have been protected by overload relays, automatically stopping them at or a little before the danger point, in various instances it is extremely inconvenient to have a motor stop while in operation. Sometimes, where tungsten-carbide cutters are involved, tool breakage has resulted.

The ammeter makes proper motor protection visual, yet leaves time of actual motor stoppage or change in the hands of the operator. To this, of course, are added various advantages contingent on being able to actually watch motor load at all times, thereby operating a machine at maximum efficiency.

Special Brazing Furnaces

SPECIAL brazing furnaces have been designed and installed by the Griscom-Russell Company, Massillion, Ohio, to assist in the fabrication of recent products for high-temperature heat-transfer services, or other services in which brazed construction can be used advantageously.

The furnaces are capable of brazing ferrous and nonferrous products of various types and in various size ranges. Initial use of the furnaces will be for the following:

1 The high-temperature K-Fin, consisting of stainless-steel clad copper fins brazed to stainless-steel tubes. This high-temperature heat-transfer element can be used to heat or cool a gas on the shell side, with a liquid or high-pressure gas on the tube side. It can be used with tube-side temperatures as high as 1600 F, and with shell-side temperatures as high as 2600 F.

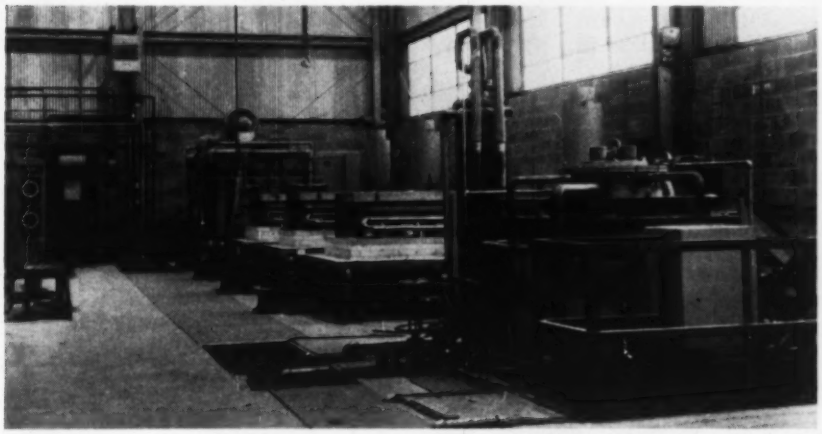
2 The Griscom-Russell plate-fin exchanger, constructed of mild steel coated and brazed with a Griscom-Russell nickel-base alloy, is intended for high-temperature gas-to-gas applications. These applications include gas-turbine regenerators, furnace or kiln air preheaters for recovery of stack-gas heat, process gas, or air heaters utilizing waste heat, heat-recovery units for use with catalytic industrial-gas purification systems, etc.

3 A special K-Fin made of mild steel coated and brazed with a Griscom-Russell nickel-base alloy for applications less severe than those that would require the high-temperature K-Fin, but where brazing and coating of the assembly is desired.

The new facilities consist of a bell furnace with four retort bases in which the plate-fin cells are brazed, a vertical furnace in a pit for brazing the K-Fin tubes, special gas-atmosphere equipment, and the necessary handling and control equipment.

The bell is transported from one base to another by a crane. The pit furnace is 13 ft sq and 24 ft deep. The vertical furnace within the pit is 6 ft in diam and 29 ft high, extending 5 ft above ground level.

The process requires that the parts being brazed be enclosed in a controlled gas atmosphere, with brazing temperatures up to 2000 F. Because of the high temperature, the retorts are constructed of Inconel. All furnaces are heated externally by natural-gas firing.



In this view of Griscom-Russell's new furnace room, the four retort bases for brazing plate fins are shown in the background at *right*, with the furnace bell in place on the rearmost base. In the right foreground is the top of the pit furnace in which K-Fin tubes are brazed. The control board and analyzer are shown in the background at the left of the rearmost plate-fin furnace.

Electric-Energy Production

PRODUCTION of energy by electric utilities in the United States during 1955 reached a record of 546,404,320,000 kwhr, while output for the month of December, 1955, passed the 50 billion kwhr level for the first time, according to preliminary figures released by the Federal Power Commission in its "Production of Electric Energy in the United States" series.

Out of the record total for the year, hydro plants generated 112,720,796,000 kwhr, or 20.6 per cent, and fuel-burning plants accounted for 433,683,524,000 kwhr, or 79.4 per cent of the total. Total utility production was up 15.8 per cent from 1954, when the previous record was set. Utility hydro output gained 5.3 per cent and thermal production 18.9 over 1954 levels.

Combined utility and industrial production for the year was 624,901,706,000 kwhr, 14.7 per cent higher than in 1954. Industrial

production alone was 78,497,386,000 kwhr, also a record and 7.6 per cent over 1954. Year-end utility capacity was 114,371,396 kw, a gross increase of 12,536,008 kw and a net gain of 11,778,986 or 11.5 per cent for the year. Utility and industrial capacity together totaled 130,413,461 kw at the end of 1955.

For the month of December, production by electric utilities totaled a record 50,715,190,000 kwhr, an increase of 2.8 per cent over the previous high of 49,353,484,000 kwhr produced during August, 1955. The December total was 16.7 per cent more than the 43,448,665,000 kwhr produced in the similar month a year earlier.

Water-power plants produced 9,306,741,000 kwhr in December, a 2.9 per cent gain over production from this source in December of 1954. As a per cent of December total production, water-power output decreased from 20.8 per cent in 1954 to 18.4 per cent in 1955. Production by fuel-burning plants in December was 20.4 per cent above that for December, 1954.

Industrial production, including generation by railway and railroad plants, was 6,855,711,000 kwhr in December, a 6.4 per cent increase over the similar month in 1954. Preliminary generating capacity was 16,042,065 kw on Dec. 31, 1955, on the basis of preliminary summaries.

Combined utility and industrial production in December was 57,570,901,000 kwhr, an increase of 15.4 per cent compared with December, 1954.

1800-Hp Diesel Locomotive

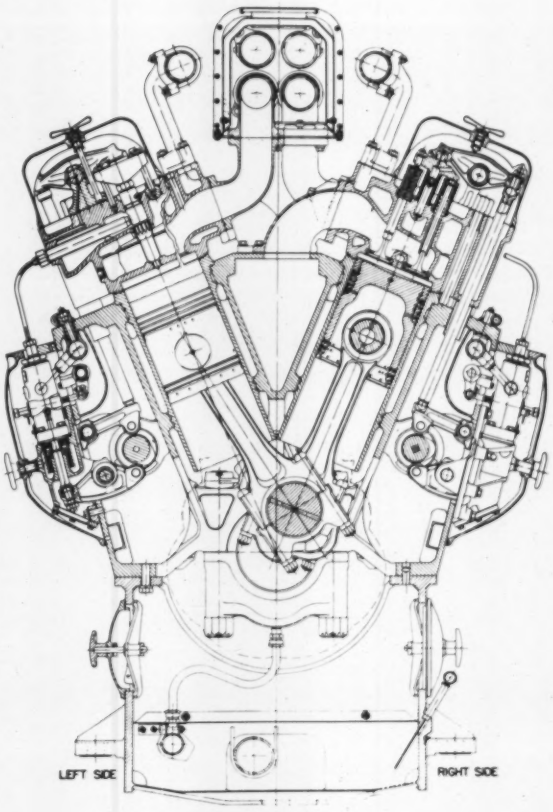
A NEW four-motor diesel-electric locomotive was introduced recently by ALCO Products, Inc. The power plant for the versatile road switcher is a new design, 12-cylinder, 1800-hp Vee-type model 251 ALCO engine.

The DL-701 locomotive displayed at Schenectady is the first off the production lines. However, ALCO holds orders for substantial numbers of the new units and several additional orders are pending.

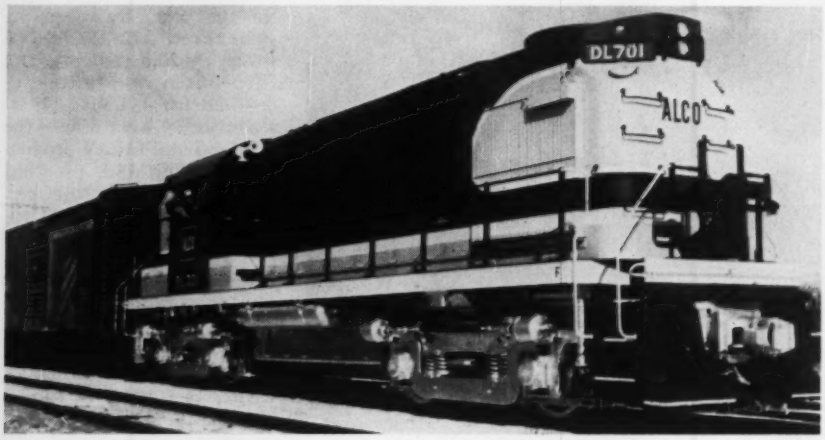
251 Vee-Type Engine

The new 251 engine eliminates the free-end casing, camshaft idler gears and camshaft casing, water jackets, and generator adaptor used in ALCO's model 244 engine. The 251 is turbosupercharged and has an air-intake aftercooler that effectively lowers temperatures in all combustion-affected parts.

Working parts in the new engine are totally enclosed to decrease wear, and a new fuel-injection system affords



Cross section through Vee-type 251 engine looking from generator end



New ALCO DL-701 diesel-electric locomotive speeds along tracks at Scotia, N. Y. An all-new, 1800-hp model 251, 12-cylinder, Vee-type engine powers the unit.

improved combustion with the added benefit of being dilutionproof.

Longer cylinder and valve life is forecast by ALCO engineers, who have incorporated valve-seat inserts and hardened valve faces in the 251 engine. Piston and piston-ring longevity also has been increased, according to engineers, by a new niresist insert piston, while piston rings are heat-treated to make them compatible with the engine's chrome-plated cylinder liners.

The cylinder block of the new engine is stronger and heavier than that of previous ALCO engines. The 251 Vee-type has a wider and stronger center main bearing, with serrated fit between all main bearing caps and saddles. Grooveless main and connecting-rod bearings increase oil-film thickness by more than 100 per cent, according to ALCO engineers.

The new engine includes a positive-action, mechanical overspeed trip that enhances the safety aspects of the heavy-duty power plant.

Improvements in the DL-701

The DL-701 locomotive incorporates several improvements over previous designs. Number boxes are angle-mounted and classification lights are variable-colored and flush-mounted. The cab is longer, weathertight, and has two heaters with fresh-air intakes. Gages are of the dial type and are placed near control locations to permit convenient operation of the locomotive in either direction.

The locomotive has a wheel base of 40 ft 4 in. and a maximum height of 14 ft 6 in. Its maximum width is 10 ft $1^5/_8$ in. and it is 56 ft $11^3/_4$ in. long inside the knuckles. The wheel base of each truck is 9 ft 4 in. and truck wheels are 40 in. in diam. Roller-bearing trucks and a rubber draft gear are standard equipment on the DL-701.

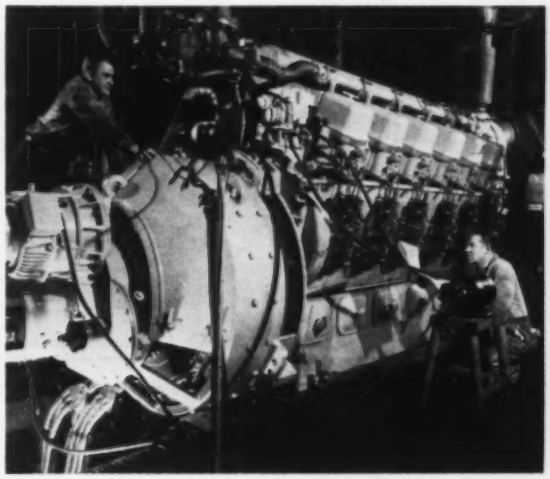
The locomotive's base weight is 240,000 lb and it can be ballasted to 260,000 lb.

Improvements in the basic electrical controls include a greatly simplified engine control with individual push-button start and stop and a simple, two-position engine-control switch with idle or isolation and run positions.

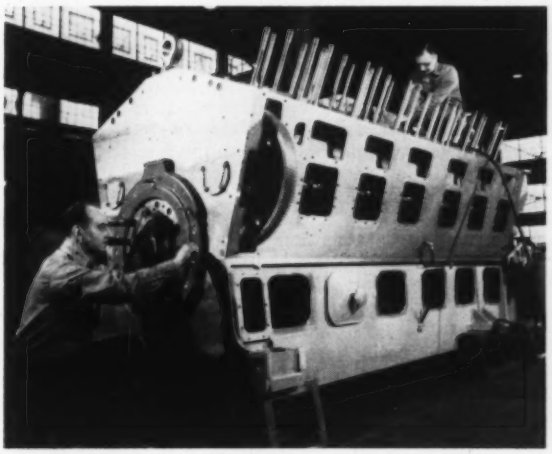
In fuel-rate control, the DL-701 governor provides timed rate of fuel advance that offers throttle-cushioned duty on the engine, cleaner exhaust during acceleration, and permits throwing the engine on the line in transit.

The number of relays has been drastically reduced, leaving heavy-duty, tamperproof relays where required.

Among modifications available to meet customer specifications are gear ratios providing four choices of speed and tractive effort. Gearing at 65 mph produces a continuous maximum tractive effort of 53,000 lb, gearing at 75 mph produces a maximum effort of 46,500 lb, 43,400 lb maximum effort results from gearing at 80 mph, and when geared at 92 mph a maximum of 38,000 lb of tractive effort is developed.



ALCO's new model 251, 1800-hp Vee-type engine on test stand, where each engine is run a minimum of nine hours under close inspection



Production-line view of ALCO's new 251 Vee-type diesel engine, showing base-block divide with camshaft gear in position

U. S. Steel Capacity

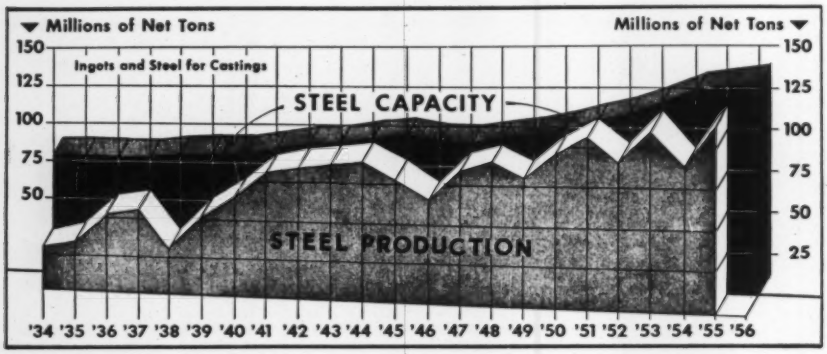
STEELMAKING capacity in the United States increased more than 2.5 million tons in the past year—to a record 128.4 million tons annually, according to *Steel Facts*, February, 1956. And it's going to rise much higher, rapidly, it is reported. Steel companies have scheduled additional expansion and improvement programs which total about 15 million tons of ingots and steel for castings during the next three years, Benjamin F. Fairless, president of American Iron and Steel Institute, pointed out.

Some companies have formulated plans even farther into the future.

More Iron and Steel Needed

A larger population with higher standards of living calls for more iron and steel, since it will need more schools, homes, highways, factories, household appliances, churches, canned goods, freight cars, automobiles, and countless other products demanded by a growing progressing country.

Even now, the annual steelmaking capacity—totaling 128,363,090 net tons of ingots and steel for castings—is 40 per cent higher than at the end of World War II. In this 10-year interval, the steel companies have raised



Growth of steel capacity, net tons, ingots and steel for castings, from 1934 through 1955

the potential output of the world's largest steel industry nearly 36.5 million tons.

Steelmaking capacity has gone up more rapidly than the population of this country. Population increased about 21 per cent in the 10-year period, compared with steel's 40 per cent rise. Now the capacity is equivalent to 1550 lb of steel annually for each person, against 1340 lb at the start of 1946.

Blast-furnace capacity went up 1,514,130 net tons during 1955, and is now rated at a record 84,485,230 tons annually. Total blast-furnace capacity has increased 25.5 per cent since the end of World War II, and there are 20 more furnaces operating than at that time. The industry's by-product coke capacity is now rated at 69,416,400 net tons a year, a slight gain over the total at the start of 1955. In addition, many facilities other than equipment directly related to iron and steelmaking were expanded and improved during 1955. The companies enlarged their rolling-mill capacities, built continuous galvanizing lines, heating furnaces, and many other types of equipment.

Billions of Dollars Spent

This expansion by iron and steel companies, large and small, has been very costly. Altogether they have spent more than $7 billion in the past decade. An additional $1.2 billion will be spent this year.

But billions of dollars more will be required for the expansion in future years. Where can these billions be obtained? That is a very grave question, according to steel executives.

In order to operate the immense steel capacity of the future much long-range planning is being done. Vast tonnages of iron ore, coal, limestone, scrap, and other materials will be required. Additional equipment will be needed. The required amount of fuel oil, natural gas, and electricity will be considerably larger than at present.

The industry's technological work will be intensified. Small improvements, as well as big spectacular developments will be needed.

Last year's increases in steelmaking capacity took place in 15 states. The largest gain occurred in Pennsylvania, where the combined capacity rose 987,670 tons.

New York became the fifth largest steel state. Formerly it was sixth. Pennsylvania, Ohio, Indiana, and Illinois remain the four largest steel producers, in that order. Michigan is sixth, followed by Maryland and Alabama.

The Pittsburgh-Youngstown steelmaking district made the largest tonnage gain among the six steelmaking districts, the increase being 1,158,110 tons. The next largest gain was in the Eastern district at 1,027,300.

Gas-Sampling System

A NEW gas-sampling system for the measurement of O_2 content in open-hearth flue gases has been designed by Leeds and Northrup Company, Philadelphia, Pa., for use with their magnetic-type oxygen analyzer. The system solves the difficult problem of obtaining a continuous dirt-free sample with a minimum of maintenance. Reliable measurement of O_2 content as an index of furnace performance offers the promise of faster heats and thus increased steel production.

In the arrangement of a typical analyzer system for an open-hearth furnace, sampling tubes with accessory equipment are installed in each down-take and connected by $^1/_4$-in-OD copper tubing to the analyzer. The analyzer and its recorder or recorder-controller can be located up to 200 ft from the sampling point, with as little as five seconds lag in the sampling line.

One such system is installed at Jones & Laughlin Steel Corporation in Pittsburgh, Pa. Here, a recorder-controller is used to adjust the fuel-air ratio automatically for optimum combustion efficiency. Here, also, L&N engineers co-operating with those of J&L completed their field tests on the new sampling system.

Sampling-System Design

The sampling system comprises (1) a water-jacketed probe, (2) a steam ejector, (3) a jet condenser, and (4) a centrifugal separator. Each component has a key role in providing a dirt-free sample under continuous trouble-free operation.

The sample probe has an outer jacket through which water continuously circulates to cool the tube against the effects of the high-temperature flue gas. In the center of the probe a tube carries filtered water to a nozzle assembly which washes the probe opening with jets of water. These jets keep the end free of slag. Small radial sprays from the nozzle flush the sample passage to prevent accumulation of dirt.

The mixture of flue-gas sample and wash water are drawn from the probe by suction of a steam ejector. Steam thoroughly mixes with the gas and dirt, and the mixture passes to a jet condenser. In the condenser, a water jet causes the steam to condense, thereby wetting the dirt particles thoroughly so that they can be removed in the centrifugal separator. The condensation process also removes corrosive gases.

Water and wetted dust are spun to the outer periphery of the separator and then flow to the bottom. The clean gas sample leaves the top of the separator, under positive pressure which delivers it to the analyzer at high velocity and eliminates chances of sample contamination due to leaks in the piping. And this thoroughly scrubbed, acid-free sample assures minimum system maintenance by eliminating plugging or corrosion of the sample line.

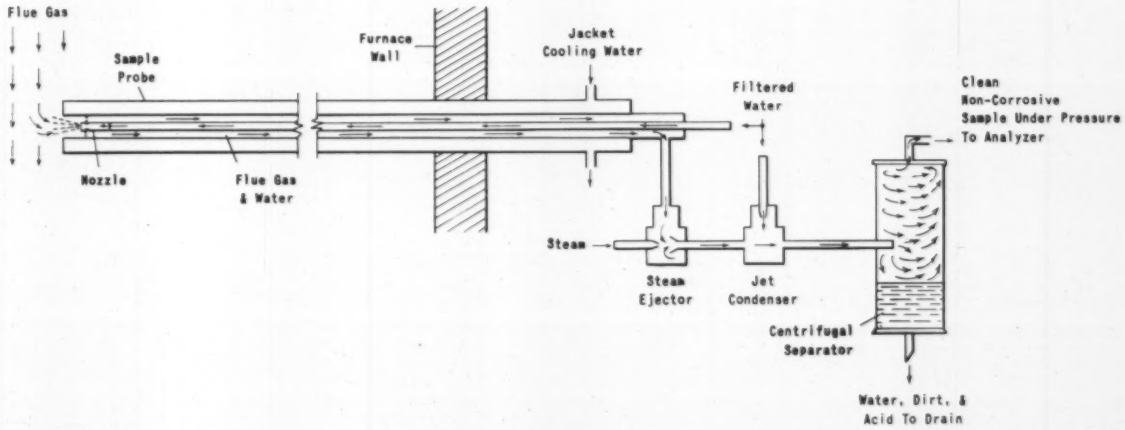
Sample Reversed With Furnace

The two gas sample lines from the sampling systems are connected to a reversing valve at the analyzer-recorder panel. This valve is operated automatically during furnace reversals to connect the exhaust downtake side to the analyzer. At the same time, the sample from the opposite furnace end is vented to atmosphere.

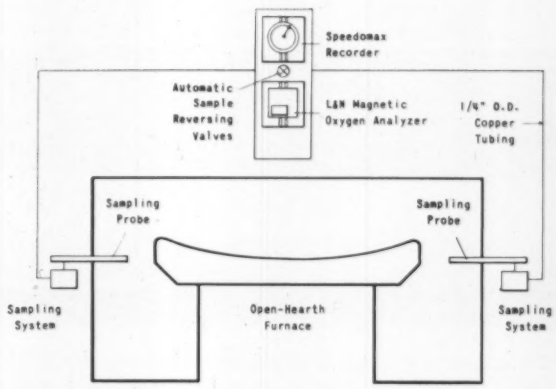
Thus, except for the brief period after reversal (before furnace conditions have stabilized to the point of producing a significant O_2 measurement), the system provides a continuous oxygen analysis of the open-hearth flue gas, regardless of the frequency of reversals.

The gas sample from the automatic reversing valve enters the analyzer through a separator where any condensate formed in the sampling line is removed. It then passes through a filter and rotameter assembly which maintains a constant rate of flow to the analyzer cells.

In the analyzer, the oxygen content of the sample is measured by the unique paramagnetic properties of oxygen (i.e., it is strongly attracted to a magnetic field). With an electrical circuit designed to minimize errors due to changes in gas pressure, the analyzer produces a signal directly proportional to the O_2 content of the gas. This signal is measured by an L&N electronic recorder calibrated directly in per cent of oxygen (normally 0 to 10 per cent O_2 for open-hearth flue gas).



Schematic diagram showing arrangement of Leeds & Northrup oxygen-analyzer system for open-hearth furnaces

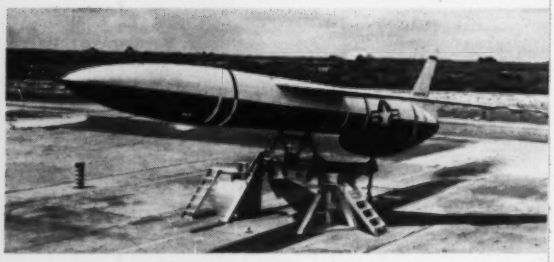


Schematic diagram of L&N's specially designed system for open-hearth gas sampling

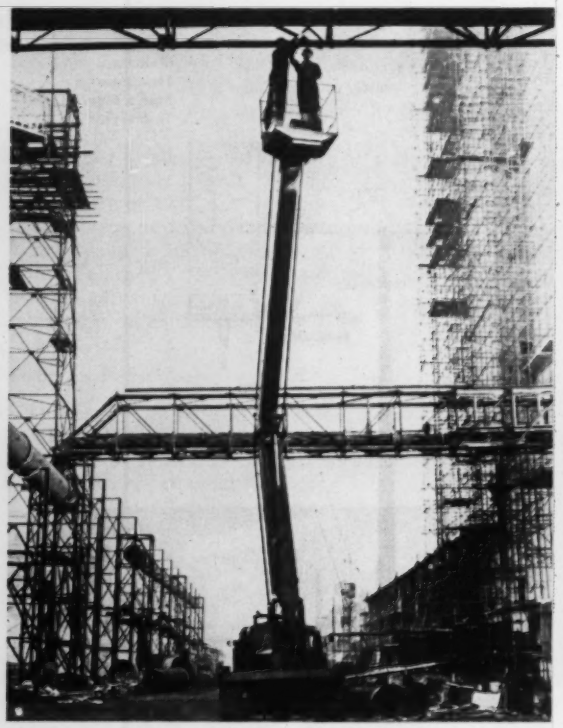
View of panel board containing L&N's oxygen analyzer and (above it) the recorder-controller

Engineering Developments . . .

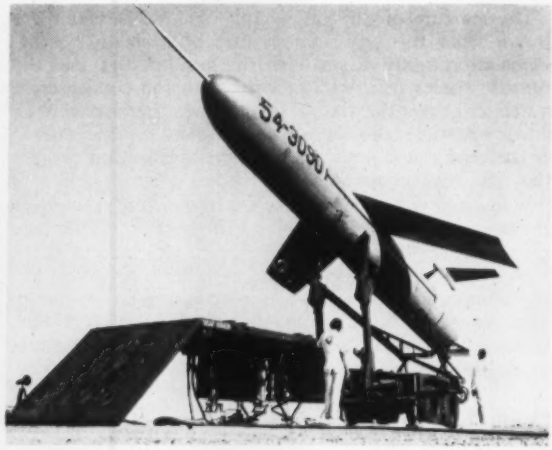
. . . at a glance



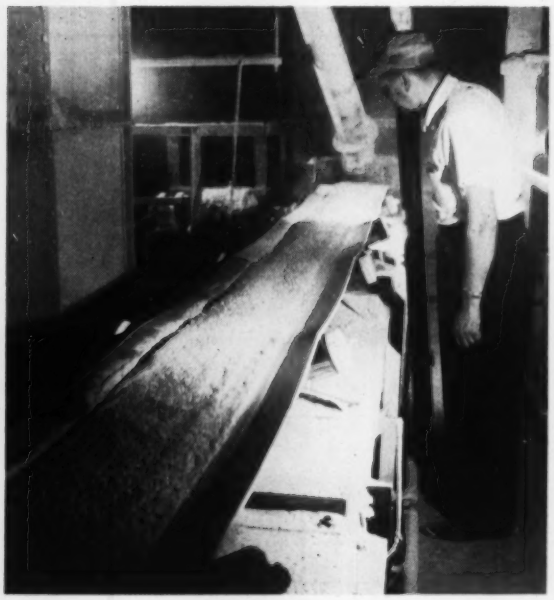
Intercontinental Guided Missile. First U. S. Intercontinental guided missile to be unveiled by the U. S. Air Force, the USAF's Northrop Snark SM-62, perches on a cleared pad at Patrick Air Force Base, Fla., where missile is undergoing tests. The Snark, a winged pilotless bomber capable of delivering an atomic warhead over trans-oceanic distances.



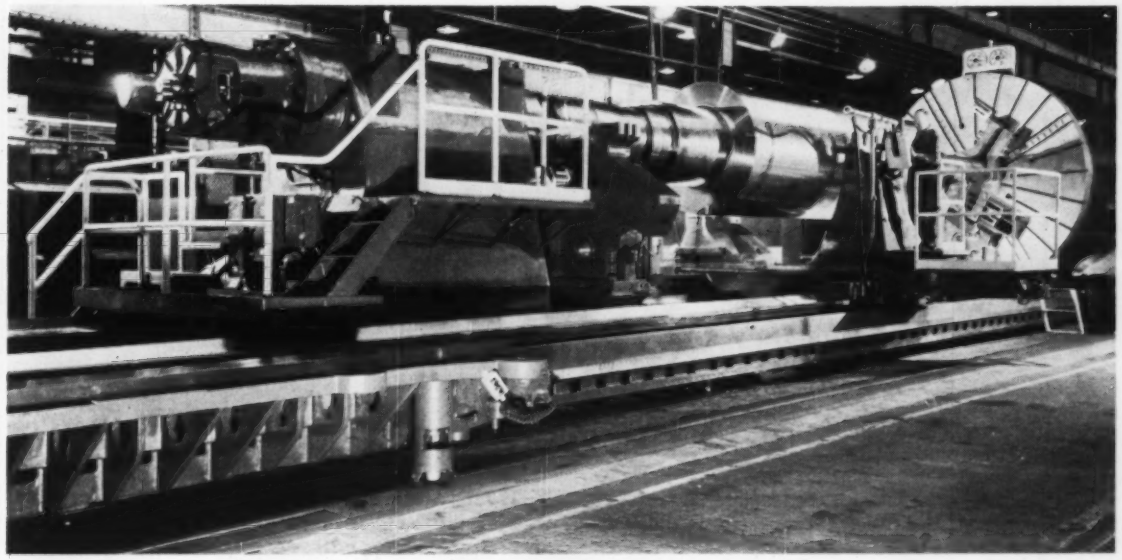
Platform for Industry. A hydraulic platform that lifts two workmen to a height of 40 ft, doing away with scaffolding, block-and-pulley rigs, and other time-consuming tackle, will be shown at the second part of the British Industries Fair, London and Birmingham, England, April 23–May 4. All movements are controlled by the workmen from the platform, by pedals for raising and lowering, and by a knee-operated rotation control. The platform is manufactured by Simon Hydraulic Machinery, Queen's Cross, Dudley, Worcestershire, England.



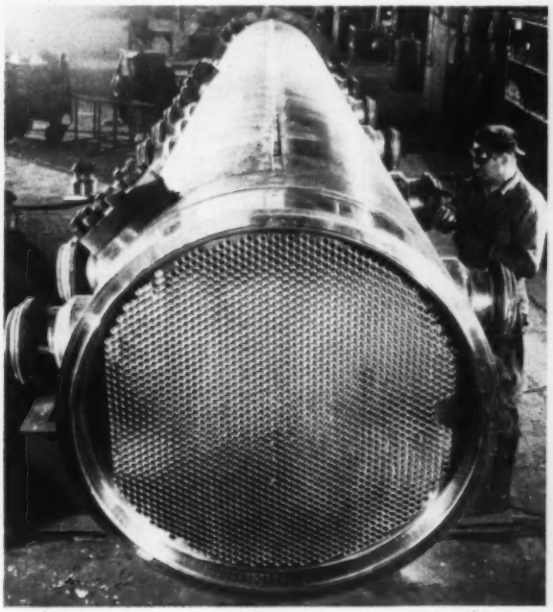
Tactical Missile. The Martin Company recently announced that successful test firings have been made with this version of the Martin Matador tactical missile, known as the TM-61B. The new missile is longer, and carries a larger nose section than the present USAF TM-61 Matadors. TM-61B test firings have been performed at the Air Research and Development Command's Holloman Air Force Base in New Mexico.



Heat-Resistant Conveyer Belt. This test length of new "Solarflex" hot-material belt made with special heat-resistant rubber, has outlasted three conventional hot-material belts on this drive. The belt handles hydrated lime at 250 to 300 F. Cover and carcass of the Solarflex belt are still flexible and fabric reinforcement has not lost its strength. Each of three successive conventional belts, into which this same test section of Solarflex was spliced, failed as rubber covers hardened. The new Solarflex construction was developed by The B. F. Goodrich Company, Industrial Products Division, Akron, Ohio.



Machining Rotor Forgings. This 144-in. engine lathe in the Allis-Chalmers West Allis Works is used to machine a rotor forging for a 300,000-kw steam turbine-generator unit. The newly installed lathe is one of the largest ever made and measures 60 ft between centers. Its 200-hp drive motor and the motors used for supporting generator excitation have magnetic amplifier control. The 10-hp carriage armature is controlled electronically. The carriage follows the spindle speed giving a constant feed which is adjustable from 0.003 to 0.75 ipr. The rotor is for the 146,000-kw, 1800-rpm, 18,000-volt generator on the cross-compound steam turbine-generator unit. It is 5 ft at its greatest diameter, 35 ft long, and weighs 200,000 lb.



Atomic Power Plant Heat Exchanger. One of the steam-generator heat exchangers for the nation's first civilian nuclear power plant at Shippingport, Pa., near Pittsburgh, is pictured nearing completion at Carteret, N. J., works of Foster Wheeler Corporation. It is a vital part of the 60,000-kw plant being designed and built by Westinghouse Electric Corporation for Duquesne Light Company and the U. S. AEC.

Radiographing Huge Pressure Vessels. Detecting possible flaws in vital welds is one of the first assignments of this gamma-ray projector recently introduced by The M. W. Kellogg Company. Shown here, it has been positioned on a fork-truck inside the pressure vessel, while the film to be exposed subsequently by the radioactive source is being attached to the vessel's exterior.

European Survey

Engineering Progress in the British Isles and Western Europe

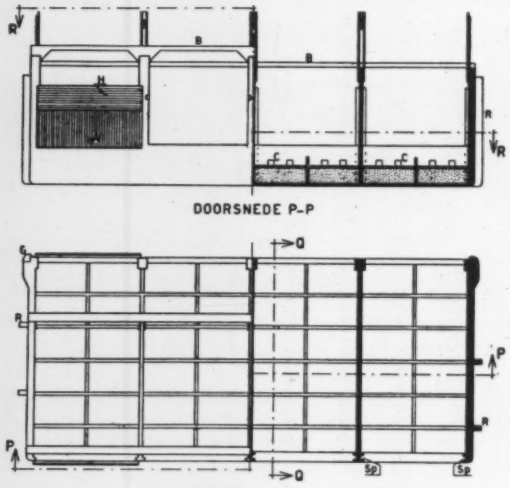
J. Foster Petree,[1] Mem. ASME, *European Correspondent*

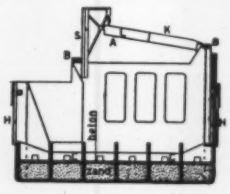
Sluice Gate for Closing Dikes

THE construction of a dike across a large tidal inlet is comparatively a straightforward undertaking until the final stages are reached, when the remaining opening is so far reduced in width that the rush of water through it is such as to sweep away the material as fast as it is deposited. This problem has been studied closely in Holland, in view of the schemes which are under consideration for closing some of the channels at the mouth of the Scheldt and between the Friesian Islands. The latest development is a special design of sluice, so constructed that it can remain open while being placed in position and can then be closed, and finally buried in the dike. The design is the work of Irs. Jitta, Dibbits and de Wolff, of the Rijkswaterstaat, the Dutch Government department which is responsible for waterways in Holland, and is described in an article by Ir. M. J. Loschakoff in the Dutch journal *De Ingenieur* of Feb. 10, 1956.

As shown in the sectional diagrams, the sluice consists of a reinforced-concrete caisson containing four compartments with wide openings in the walls, through which the water can flow. On the upstream side these openings can be closed by hinged steel doors, suspended from the top of the wall and raised or lowered by means of tackle attached to derricks. On the downstream side temporary closing is effected by wooden doors, and permanent closing, in due course, by concrete beams, lowered into vertical slots formed in the sides of the openings. The bottom of the caisson is formed of open cellular construction, in which sand ballast is pumped to sink the caisson in position. A certain amount of initial ballast is required to enable the caisson to be towed to the site, and this ballast is held down by a thin deck of concrete, so that the rush of water will not wash it away. In the diagrams, the upstream gates are indicated by A; they are cellular, with air spaces, L, between the outer plates, K. Longitudinal beams, B, connect the bulkheads between the compartments. The wooden doors are shown at H, and the grooves for the permanent concrete balks at Sp. Provision is made to fit wooden gates on the upstream side also, until such time as the steel flaps are in position and ready to be lowered by the derricks, S. The over-all length of the caisson is about 150 ft. Vertical ribs, R, are formed on the end walls, to interlock with an adjoining caisson if more than one is being used; and spuds, G, are provided on the upstream corners, as indicated. When in position, the caisson will be filled completely after the material of the dike has been banked up outside it, the berm of the dike being about level with the highest point of the caisson, and the crest of the dike several meters higher.

[1] Correspondence with Mr. Petree should be addressed to 36 Mayfield Road, Sutton, Surrey, England.

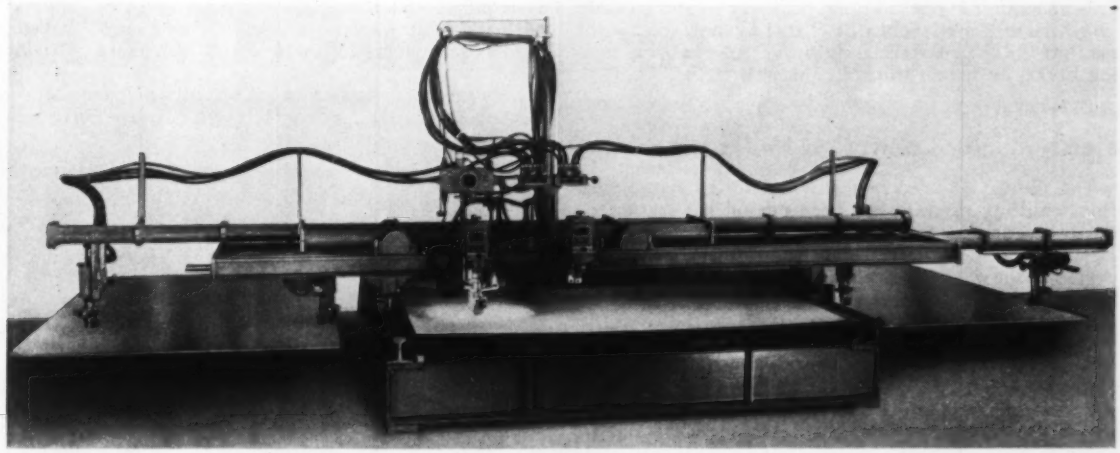




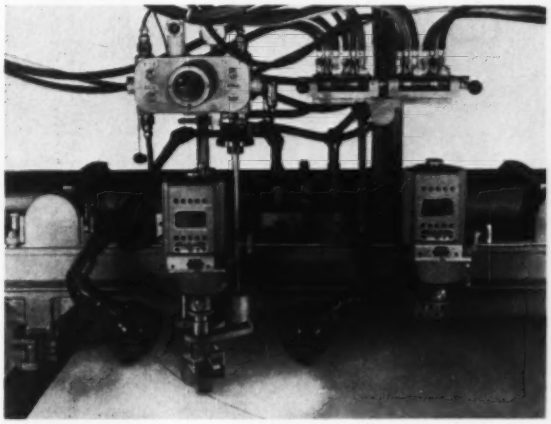
Sluice-gate caisson for closing dike in tidal waters

Duplex Flame-Cutting Machine

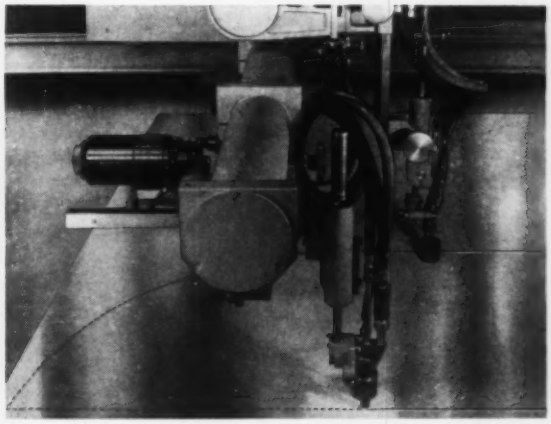
THOSE unfamiliar with the terminology of ship construction may not be aware that the term "floor", in maritime usage, does not mean a horizontal surface; floors in a ship are the transverse vertical plates connecting the frames to the keel. It follows, therefore, that the bottom edge must be shaped to fit the curvature of the frame to which it is attached, and that floors must be made in pairs, to be fitted to port and starboard of the keel. They are usually shaped in flame-cutting machines. It is possible to cut out two floors at once, one being clamped on top of the other, but a better finish is obtained by cutting through one thickness only. To combine the speed of the former method with the finish of the latter, Hancock & Co. (Engineers) Ltd., Progress Way, Croydon, England, have developed a duplex flame-cutting machine which cuts two plates simultaneously, one on each side of the table carrying the template or drawing.



Hancock duplex flame-cutting machine which has been developed for cutting two ships' floor plates simultaneously



Tracing head of duplex flame-cutting machine is fitted with handwheel steering for operation from a drawing or a groove



Accelerating drive for straight-cut burner, *front*, to move it out of the way of the curve-cut burner, *behind*

There are four burners, two sides of each plate being cut at once. The carriage is mounted on hardened and ground wheels, running in ball bearings, and supports an upper carriage, similarly mounted, but moving at right angles to the motion of the lower carriage. To make a straight cut, two fixed burners are attached to the lower carriage, one close to the main rails and the other, which is adjustable, on the outside of the cutting area. The other two burners, which make the curved cuts, are attached to the top carriage. They are carried in a floating head which automatically keeps the nozzle at a preset height above the plate. The small castor wheels which run on the plate are mounted in ball bearings and are air-cooled, as they are in close proximity to the burner. As the two sets of burners approach the narrow end of a curve-cut plate, the straight-cutting burner and the curve-cutting burner come nearer to each other. To prevent them from colliding where the cuts intersect, the straight-cutting heads are mounted on short slides, operated by rack and pinion from variable-speed motors, so that their motion can be accelerated to clear the path of the curve-cutting burners. The method of mounting all four heads allows them to be swiveled to cut bevels at any angle up to 45 deg on either side of the vertical. The tracer head is fitted with handwheel steering, to operate either directly from a drawing or from a groove in a scrieve board. Alternatively, a normal tracer head can be fitted, for ordinary profiling work.

Scientific Instruments Showroom

THE Scientific Instrument Manufacturers' Association of Great Britain (a title usually abridged to "Sima") has opened at its headquarters, 20, Queen Anne Street, London, W. 1, a permanent showroom for the products of its 140 member firms. Sir Norman Kipping, Director-General of the Federation of British Industries, in opening the exhibition, stated that the industry now employs some 50,000 persons and has an output valued at £60 million a year. The space available in the Sima headquarters not being sufficient to enable all the member

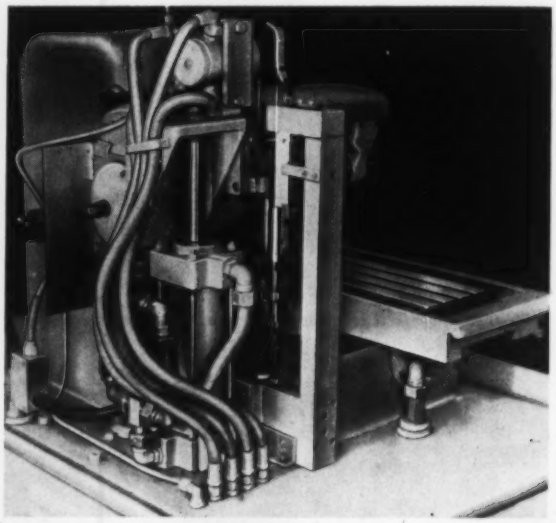
firms to exhibit at one time, a rota system has been drawn up which will give them all a chance in turn, so that the exhibits will be constantly varying. An extensive catalog library is included in the equipment.

Electronically Controlled Milling Machine

THE Centec 3R electronically controlled two-dimensional milling machine has been put on the market recently by the Central Tool & Equipment Co., Ltd., of Hemel Hempstead, Hertfordshire, England, and is a development of their Centec 3 machine. The table feed is hydraulic and steplessly variable, the automatic operating cycle giving a fast approach to the work (at 300 ipm) and then a slow feed and a fast return. The traverse is 14 in. For the vertical movement of the cutter the head slides bodily up and down on its column, and for the cross movement the quill containing the spindle moves in and out on the head; these motions are controlled by handwheels for setting up the work. The main drive is by a d-c motor, controlled electronically from a 3-phase a-c supply. The machine can be supplied with either of two speed ranges, 50 to 1400 or 200 to 2800 rpm.

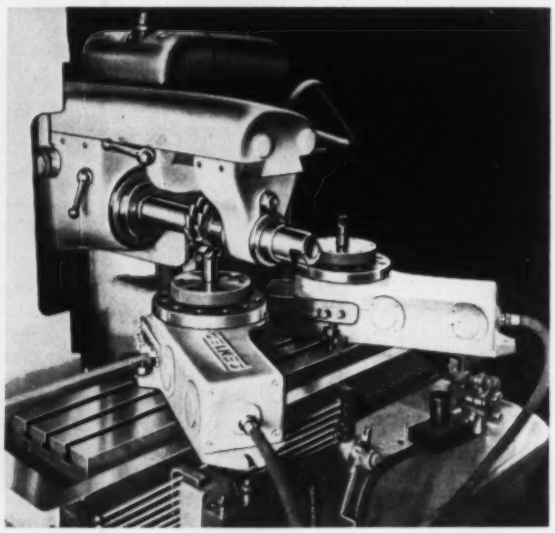
The spindle speed is controlled by a single dial operating a rheostat, providing infinitely variable speeds, and a two-speed gearbox splits the speed ranges into 50-275 and 275-1400 or 200-550 and 600-2800 rpm. The spindle can be fed down to six different levels, which are preset as required and controlled by positive stops, and, as with the table traverse, a solenoid pilot valve provides a fast approach, followed by a steplessly variable feed.

No cams are necessary to set up any cycle, the movements being actuated by contact with buttons, positioned in slotted holders. A holder, with its set of buttons, can be removed readily and stored complete until it is needed for use on a repeat batch of work. The ability to combine the head and table motions greatly reduces feed times.



Back of head of electronically controlled two-dimensional milling machine (with cover removed) showing stops for six depths of feed

Centec 3R electronically controlled two-dimensional milling machine



Rig with two indexing tables for milling a square at the end of a round component. (One fixture is loaded while the other is milled.) Production time per square is 20 sec.

ASME Technical Digest

Substance in Brief of Papers Presented at ASME Meetings

Gas Turbine Power

The Filtration of No. 6 Fuel Oil to Remove Undesirable Trace Metals, by C. H. Shields, Jr., General Electric Company, Schenectady, N. Y. 1955 ASME Diamond Jubilee Annual Meeting paper No. **55—A-121** (multilithographed; available to Oct. 1, 1956).

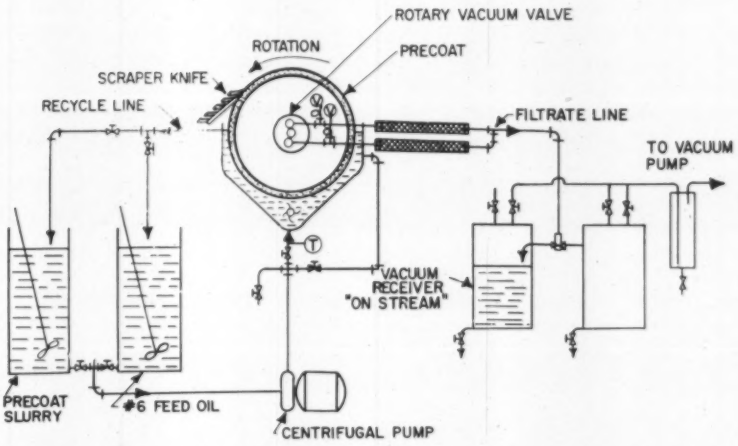
THE studies of the removal of trace metals from No. 6 fuel oil by filtration primarily for gas-turbine service are covered in this paper. Residuals such as No. 6 fuel oil offer attractive reductions in fuel costs which are often not realized because of disadvantages such as high viscosity, high ash content, and excessive frictional wear and corrosion tendencies. In the field of gas turbines, for example, fuel-cost reductions are offset by losses due to seriously accelerated corrosion of buckets and other high-temperature turbine parts. Studies have traced this trouble to metal or metal-ion impurities in the oil such as sodium, vanadium, and calcium which form a corrosive sticky ash. These impurities have their origin not only in the crude oil itself, but also in chemical refining processes and contamination by sea water during shipment.

A number of processes planned to remove these metals or inhibit their corrosive activities have been investigated by gas-turbine manufacturers and others, and the author furnished a bibliography on these activities. One of the possible methods which was selected for study was filtration.

Materials were first evaluated in batch-filtration tests. One of the higher solids content No. 6 fuel oils was chosen as the test oil. It had a viscosity of 1150–1275 centistokes at 100 F, a water content of about 0.2 per cent, and sodium and calcium concentrations up to several hundred ppm each.

Using a vertical leaf laboratory precoat filter, the oil was passed through precoat cakes deposited from transformer oil slurries of several grades of diatomaceous earth and calcined clay. Analyses for trace metals soon indicated at least a partial solution to the metal problem, but as was anticipated, cake plugging was serious. Analysis of precoat cake strata indicated primarily surface collection of contaminants, and further experiments suggested that the problem of plugging might be met by use of a continuous rotary precoat filter, in which a doctor knife constantly removes surface layers of the precoat filter cake as they become plugged.

It was found that (1) precoat filtration through diatomaceous earth can reduce the sodium concentration in No. 6 fuel oil to about 2 ppm from original concentrations of over 200 ppm; (2) calcium, iron, aluminum, lead, and magnesium, as well as sediment and total ash are substantially reduced; (3) present data indicate that the process using a continuous rotary precoat filter is economically feasible.



Schematic diagram of model continuous rotary vacuum precoat filter installation used in experimental filtration of No. 6 fuel oil

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Combination Gas-Turbine and Steam-Turbine Cycles, by M. A. Mayers, Mem. ASME, A. Matiuk, Assoc. Mem. ASME, and S. Baron, Mem. ASME, Burns & Roe, Inc., New York, N. Y. 1955 ASME Diamond Jubilee Annual Meeting paper No. **55—A-184** (multilithographed; available to Oct. 1, 1956).

THE development of two highly efficient coal-fired combination gas and steam-turbine power-plant cycles and the effects of a number of cycle variables on the plant efficiencies are discussed. Some of the engineering problems of these cycles are discussed. Investment cost estimates and evaluations are presented showing the annual production savings attainable with the combination cycles.

The principal advantage of these combustion cycles is a significant improvement in plant heat rates, which are about 6 per cent better than present-day high-efficiency reheat plants. Another advantage that should not be lost sight of is the requirement in some combination cycles of a high degree of cleaning of the boiler flue gas. Thus the stack gas discharged to the atmosphere is substantially dust-free. In view of current activity in the control of air pollution, such cleaned stack gas will ultimately be an essential characteristic of steam power plants. Obtaining it without increase in the essential cost of certain of the combination cycle plants is an undoubted advantage.

Recent advances in mechanical-engineering practice bring combination-cycle plants into the realm of present practicability. The gas turbine is now a reliable prime mover. Another major factor is the growing experience of American boiler manufacturers in the design and construction of pressure-tight boilers, which are required in some of the combination cycles. Special requirements of the United States Navy, as well as the increased use of pressure firing in station-

ary plants, have contributed to this development.

For a conventional plant to secure improvements of the order of 6 per cent in plant heat rates would require equipment designed for supercritical steam pressures, temperatures of steam above 1050 F, and multiple steam reheating. From the standpoint of air pollution, the possibility of producing a substantially dust-free stack gas coupled to a reduction in annual production cost is a very promising development for the supercharged combination cycle. These factors of fuel economy, reduced investment cost, and reduced dust nuisance show that the supercharged combination cycle should be given further serious consideration by all groups in the power industry. There appeared to be no doubt in the authors' minds that this cycle will become an accepted means of power generation in the near future since its promise looms so large on the horizon.

The exhaust-gas combination cycle, although not as thermally efficient as the supercharged steam regenerator cycle, permits substantial gains over the conventional cycle and can be designed and built at the present time using already developed and proved equipment.

The authors urge that the power industry vigorously pursue the development of the types of combination cycles discussed in this paper. New concepts of power generation are becoming increasingly necessary to cope with rising costs. These combination cycles are significant because of the opportunity they present to meet the problem of higher costs.

The Thermodynamics of Cooled Turbines Part I—The Turbine Stage, by W. R. Hawthorne, Massachusetts Institute of Technology, Cambridge, Mass. 1955 ASME Diamond Jubilee Annual Meeting paper No. **55—A-186** (multilithographed; to be published in Trans. ASME; available to Oct. 1, 1956).

A PROCEDURE has been obtained, the paper states, for calculating the effect of cooling on turbine-stage efficiency by visualizing the flow in the blade passages as one-dimensional compressible flow in a conical tube with heat transfer and friction. The use of Reynolds analogy between friction and heat transfer permits the results to be correlated in terms of the blade-profile loss coefficient in low-speed flow, the change of passage area in the blade section, and the ratio of average blade surface temperature to the stagnation temperature of the gas relative to the blades.

Expressions have been obtained for the amount of heat abstracted in a cooled row of blades and the drop in turbine-stage efficiency due to cooling. Calculations for some typical stages have shown that with blades cooled appreciably below the gas temperature, the amount of heat removed may be as much as 5 per cent of the calorific value of the fuel per row of cooled blades and the decrease in turbine-stage efficiency as much as 3 per cent when both nozzles and blades are appreciably cooled. The use of impulse and low reaction stages reduces to a small fraction of a per cent the effect on the stage efficiency of cooling the rotor blades only.

The Thermodynamics of Cooled Turbines Part 2—The Multistage Turbine, by W. R. Hawthorne, Massachusetts Institute of Technology, Cambridge, Mass. 1955 ASME Diamond Jubilee Annual Meeting paper No. **55—A-191** (multilithographed; to be published in Trans. ASME; available to Oct. 1, 1956).

IN PART II of this paper, the reheat factor and the turbine efficiency, it was claimed, can be calculated from the stage efficiency of an uncooled turbine and for one in which the blades are cooled. A chart has been prepared for rapid computations and the author compares results with those obtained from stage-by-stage calculations showing good agreement.

The Supercharged and Intercooled Free-Piston-and-Turbine Compound Engine—A Cycle Analysis, by A. L. London, Mem. ASME, Stanford University, Stanford, Calif. 1955 ASME Diamond Jubilee Annual Meeting paper No. **55—A-147** (multilithographed; to be published in Trans. ASME; available to Oct. 1, 1956).

THE purpose of this paper is to clarify the position occupied by the supercharged and intercooled cycle variant of the free-piston-and-turbine compound engine relative to the simple cycle. Two points of view are employed in these considerations—one relating to the question whether or not to supercharge an existing simple-cycle prototype; and the second relating to the basic decision of whether to develop a super-charged-and-intercooled cycle, or alternately to develop the simple cycle for the same degree of pressure charging of the engine cylinder.

From the first viewpoint, as an example, it appears to be attractive to supercharge a 6:1 pressure-ratio simple cycle up to 8:1 by a blower of 1:33 pressure ratio. The gain is roughly 50 per cent in power output and this must be weighed against the additional complexity, bulk, weight, and cost associated with the supercharger and its turbine drive, together with the intercooler and its ducting. Moreover, the cylinder combustion rate is increased in proportion to the power gain so that cylinder and piston heat problems are more severe. From the second viewpoint, the supercharged-and-intercooled cycle possesses no significant advantage and many disadvantages.

Some Design Aspects of the Free-Piston Gas-Generator-Turbine Plant Part I—Thermodynamics and Component Characteristics, by S. L. Soo, Mem. ASME, Princeton University, Princeton, N. J., and W. A. Morain, Mem. ASME, The Cooper-Bessemer Corporation, Mount Vernon, Ohio. 1955 ASME Diamond Jubilee Annual Meeting paper No. **55—A-146** (multilithographed; available to Oct. 1, 1956).

DESIGN aspects of free-piston gas-generator-turbine plants are presented, including: Practical consideration of the effects of valve pressure drops, heat-exchanger effectiveness, cooling, combustion, and component efficiencies in the analysis of simple or compound cycles; comparison of cycles using thermodynamic charts taking into account the foregoing effects; component arrangements, and characteristics of pulsating flow through a turbine.

Some Design Aspects of the Free-Piston Gas-Generator-Turbine Plant Part II—Controls and Accessories, by W. A. Morain, Mem. ASME, The Cooper-Bessemer Corporation, Mt. Vernon, Ohio, and S. L. Soo, Assoc. Mem. ASME, Princeton University, Princeton, N. J. 1955 ASME Diamond Jubilee Annual Meeting paper No. **55—A-155** (multilithographed; available to Oct. 1, 1956).

THE authors state that, at this stage of its development, the feasibility and usefulness of the free-piston gas-genera-tor-turbine plant were established through the effort of many pioneering fundamental and developmental works. Significant published papers of these works are listed from references in the bibliography, in the order of dates. The purpose of Part I is to present some design aspects of the free-piston gas-generator-turbine plant.

The design aspects considered are: (*a*) The practical consideration of the effects of valve pressure drops, heat-exchanger effectiveness, cooling, combustion, and component adiabatic efficiencies in the analysis of simple or com-

pound cycles; (*b*) the comparison of simple and compound cycles using thermodynamic design charts taking into account the foregoing considerations; (*c*) component arrangements; and (*d*) characteristics of pulsating flow through a turbine.

From the discussions made in each individual item in the foregoing, it was concluded that:

1 While the percentage valve pressure drop of both inlet and discharge valves affects greatly the plant performance, the inlet-valve pressure drop is most significant in affecting the volumetric efficiency of the compressor. If valve pressure drops are high, there might be no advantage at all in a two-stage compressor arrangement. Supercharging is unique in reducing the space requirement of the plant due to its contribution to equivalent volumetric efficiency.

2 Where compounding is justified from space and weight considerations, supercharging provides the highest "power density," but two-stage compression has the advantage of reducing the air-temperature rise in the compressor cylinder.

3 Intercooling reduces the work of compression, but aftercooling also can be beneficial in reducing jacket-cooling loss by lowering the temperature level of the power cylinder.

4 Outward compression renders a gas generator more flexible in load changes and calls for less idling fuel than inward compression. These aspects are especially important in locomotive devices where an engine might idle for several days.

5 Large exhaust-gas receiver volume gives better plant performance. The necessary receiver volume can be considerably reduced by synchronized operation of two or more units.

6 Most of the foregoing criteria apply to crank-type compound engines.

In Part II, Controls for Free-Piston Machinery, the authors state the control of free-piston gas-turbine machinery can be accomplished simply and directly once a sound concept of the energy balance is achieved. A clear understanding of the effects of changes in the quantity of fuel burned or in the bounce-cylinder pressures is also required. The amount of fuel burned controls the length of the power stroke, the amount of air in the bounce cylinders controls the return stroke; it is as simple as that.

There is a wide choice in the methods of control available to the designer, because of the extreme flexibility of the gas generator without a fixed crank. So many methods have been proposed in the literature that the selection of the most practical scheme for a particular arrangement of machine becomes the chief problem.

There are certain fundamental tasks to be accomplished and the authors outline the principal problems and later discuss them in detail. For example, starting, load control, bounce control, optimizing controls, and protective controls are defined and then treated rather thoroughly.

Correlation of Fir-Tree-Type Turbine-Blade Fastening Strength With Mechanical Properties of Materials, by A. G. Holms, Mem. ASME, and A. J. Repko, NACA, Lewis Flight Propulsion Laboratory, Cleveland, Ohio. 1955 ASME Diamond Jubilee Annual Meeting paper No. **55—A-122** (multilithographed; to be published in Trans. ASME; available to Oct. 1, 1956).

SOME materials under consideration for aircraft gas-turbine disks are notch-sensitive at certain operating times, temperatures, and stress levels. Prediction of engine life requires knowledge of the type of mechanical property test that will correlate with engine life and requires knowledge of the quantitative relationship. Elevated-temperature time-dependent spin tests were run on model disks with fir-tree blade fastenings. Material and test conditions were selected to cover a wide range of notch sensitivity. Results showed that life for tensile mode failures could be predicted from notched rupture tests.

Some Design Aspects of the Free-Piston Gas-Generator-Turbine Plant—Part I, Thermodynamics and Component Characteristics, by S. L. Soo, Assoc. Mem. ASME, Princeton University, Princeton, N. J., and W. A. Morain, Mem. ASME, The Cooper-Bessemer Corporation, Mount Vernon, Ohio. 1955 ASME Diamond Jubilee Annual Meeting paper No. **55—A-146** (multilithographed; available to Oct. 1, 1956).

DESIGN aspects of free-piston gas-generator-turbine plants are presented, including:

Practical consideration of the effects of valve pressure drops, heat-exchanger effectiveness, cooling, combustion, and component efficiencies in the analysis of simple or compound cycles; comparison of cycles using thermodynamic charts taking into account the foregoing effects; component arrangements; and characteristics of pulsating flow through a turbine.

From discussions covered in the paper, it can be concluded that:

1 While the percentage valve pressure drop of both inlet and discharge valves affects greatly the plant performance, the inlet-valve pressure drop is most significant in affecting the volumetric efficiency of the compressor. If valve pressure drops are high, there might be no advantage at all in a two-stage compressor arrangement. Supercharging is unique in reducing the space requirement of the plant due to its contribution to equivalent volumetric efficiency.

2 Where compounding is justified from space and weight considerations, supercharging provides the highest "power density," but two-stage compression has the advantage of reducing the air-temperature rise in the compressor cylinder.

3 Intercooling reduces the work of compression, but aftercooling also can be beneficial in reducing jacket-cooling loss by lowering the temperature level of the power cylinder.

4 Outward compression renders a gas generator more flexible in load changes and calls for less idling fuel than inward compression. These aspects are especially important in locomotive devices where an engine might idle for several days.

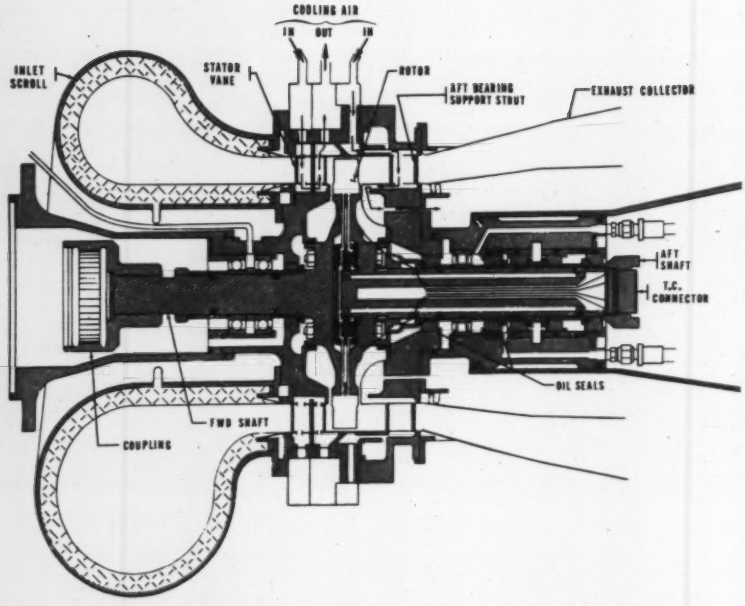
5 Large exhaust-gas receiver volume gives better plant performance. The necessary receiver volume can be considerably reduced by synchronized operation of two or more units.

6 Most of the foregoing criteria apply also to crank-type compound engines.

Application of Internal Liquid Cooling to Gas-Turbine Rotors, by Sumner Alpert, Mem. ASME, Ralph E. Grey, and Delson D. Drake, Solar Aircraft Company, San Diego, Calif. 1955 ASME Diamond Jubilee Annual Meeting paper No. **55—A-202** (multilithographed; to be published in Trans. ASME; available to Oct. 1, 1956).

APPLICATION of internal liquid cooling to the rotor and blades of a gas turbine allows the inlet gas temperature to be increased and alloys low in strategic materials to be used. A small gas turbine was designed for a gas temperature of 1750 F with lean alloy rotor materials. The design featured closed-system cooling with interchangeable blades. Cold-air tests, hot tests, and endurance tests totaling 100 hr have been run on a single-stage test turbine. Aerodynamic and thermodynamic data correlated well with expected values and the mechanical performance was satisfactory.

From the operation of a single-stage turbine, it has been concluded that the application of closed-system liquid



Cross section of single-stage gas turbine that was used for preliminary tests

cooling to the rotor of a gas-turbine engine is entirely feasible and can result in practical configurations that can yield acceptable performance. The compromises required by cooling are not drastic if a careful design procedure is used. The mechanical operation of such a unit can be developed to the point where adequate life and service can be obtained.

Data available from NACA and other sources on theoretical rates of heat transfer are usable, and correlation obtained during the test was considered to be good.

With the application of liquid-cooling, alloys containing little or none of the strategic materials can be used and adequate life obtained, provided coatings or inhibitors are used which are adequate to prevent corrosion, both from hot gases and from the coolant itself.

Based on the performance of the single-stage unit, the required performance as specified can be obtained in the three-stage turbine.

Construction of a complete three-stage turbine component is currently under way at Solar Aircraft Company, and preliminary tests have already been run on a portion of that machine involving only the first of the three stages. These tests were run to evaluate a new method of blade attachment and sealing which will eliminate the split-disk design. It is expected that the results of these and other tests on the complete unit can be reported in the near future.

Railroad Technology

History and Development of the ACF Talgo, by J. R. Furrer, American Car and Foundry Division, ACF Industries, Inc., New York, N. Y. 1955 ASME Diamond Jubilee Annual Meeting paper No. 55—A-131 (multilithographed; available to Oct. 1, 1956).

FOR the past few decades the railway passenger field has been challenged by the economics and convenience of competing forms of transportation. This competition reflects itself today in a need for a new type of equipment which should offer the railroads the following basic advantages: Reduced operation and maintenance cost; reduced initial investment; improved scheduling potential.

Certainly no single engineering device or system can be considered the ultimate solution to all problems. However, on the basis of six years and nearly one-million miles of successful revenue operation of the Talgo trains in Spain, lightweight low-center-of-gravity trains should be given serious considerations as an available solution to many of today's problems, according to the paper.

It is believed that great care must be taken in engineering the Talgo principle so that the resultant product may be easily integrated into our multi-million-dollar railroad systems. If this is done, lightweight low-center-of-gravity passenger equipment can, and should, play an important role in the future of the railway passenger field.

Adhesion—How Much? An Investigation of the Causes of Low Wheel-to-Rail Adhesion and Possible Methods of Improving It, by F. G. Fisher, Reading Company Railroad, Reading, Pa., and R. K. Allen, General Electric Company, Erie, Pa. 1955 ASME Diamond Jubilee Annual Meeting paper No. 55—A-132 (multilithographed; to be published in Trans. ASME; available to Oct. 1, 1956).

WHEEL-TO-RAIL adhesion is fundamental to the operation of a railroad. The potentially high tractive effort of modern diesel-electric and electric locomotives has focused attention more sharply on conditions which limit adhesion. Train stalls, rail burns, flat wheels, and damaged electric traction equipment all point to the importance of the problem. Extensive tests have yielded much information on the causes of low adhesion and methods of improving it. The results indicate that running adhesions in excess of 26 per cent can be maintained by the application of certain materials to locomotive drivers or to the rail.

Service Testing of Freight Cars, by O. C. Maier, Pullman-Standard Car Manufacturing Company, Hammond, Ind. 1955 ASME Diamond Jubilee Annual Meeting paper No. 55—A-139 (multilithographed; available to Oct. 1, 1956).

FREIGHT cars and their components have been subjected to thousands of tests during the nearly 10 years we have been conducting our research activities and will be put through many thousands more, according to the author. Like all freight cars, Pullman standard cars start from their owner road's tracks and travel over 25 or 30 roads before returning to their home road. Then they start the cycle all over again.

It is the maximum and most damaging conditions encountered in these assignments that are simulated in our research laboratories.

What happens when a car is subjected to shock after shock in train operation and train movement with every switching from railroad to railroad, train to train, train to siding at speeds ranging from 1 to 15 mph and at temperatures varying from 30 deg below to 110 deg above zero? The answers to these and other operating problems are extremely important to the builders, the railroads, and the shippers.

Our Research and Development laboratories, with the aid of dynamic instrumentation, and from the findings in its physical-testing, materials-testing, and welding laboratories, from its experimental construction shops have these

objectives: The continual improvement of product designs and the reduction of damage to lading.

From these laboratories, which continually measure movement and material, come facts which make it possible for the freight car to meet the constantly changing requirements for efficient economical operation.

Pullman-Standard's Train X, by T. C. Gray, Mem. ASME, Pullman-Standard Car Manufacturing Company, Chicago, Ill. 1955 ASME Diamond Jubilee Annual Meeting paper No. **55—A-140** (multilithographed; to be published in Trans. ASME; available to Oct. 1, 1956).

THIS paper establishes the several basic objectives motivating introduction of Train X, and presents in digest form a description of the more important design features calculated to meet these objectives, including a discussion of single-axle suspension, automatic coupling, structure, acoustic treatment, etc.

In summary, the accomplishments reflected in Pullman-Standard's Train X are:

1 Greatly reduced initial cost per seat. To the railroad which must constantly think in terms of capital investment, this fact is of vital importance.

2 Important dollar savings in the fields of operation and maintenance. There can be no doubt but that these major-cost segments will be very favorably influenced by the greatly reduced train weight, use of remote auxiliary power source, plastic interiors, etc.

3 Outstanding passenger comfort and appeal. Accomplishment of a pleasing and functional style (both interior and exterior), a method of compensating for undesirable body roll, and acoustical treatment for the reduction of noise levels are but prime illustrations of the "public-acceptance" principle which has influenced the entire design.

Properties of Metals

Structural Stability of Modified 12-Chromium Alloys, by W. C. Hagel and E. F. Becht, General Electric Company, Schenectady, N. Y. 1955 ASME Diamond Jubilee Annual Meeting paper No. **55—A-173** (multilithographed; available to Oct. 1, 1956).

IN ADDITION to possessing an attractive combination of mechanical properties for turbine applications, certain modified 12-chromium alloys were found to be structurally stable after long-time static aging and service exposure at high temperatures. However, two precipitation reactions have been observed to occur unpredictably in 12 Cr-Co-W-V alloy. The precipitating phases have been identified, and their effects upon mechanical properties are reported. After about 200 hr at 800 to 950 F (425 to 510 C), precipitation of chromium-rich ferrite causes decreased impact resistance and increased hardness; after about 6000 hr under stress at 950 to 1200 F (510 to 650 C), sigma formation causes an extreme decrease in impact resistance and no significant increase in hardness.

Mechanical Properties at Elevated Temperatures of Ductile Cast Iron, by F. B. Foley, The International Nickel Company, New York, N. Y. 1955 ASME Diamond Jubilee Annual Meeting paper No. **55—A-204** (multilithographed; to be published in Trans. ASME; available to Oct. 1, 1956).

THE elevated-temperature properties of ferritic ductile cast iron for 100-deg intervals from 700 to 1200 F are summarized in which the values, other than those for short-time tensile tests, have been computed by means of the Larson-Miller equation. These are quite close approximations of values to be expected from wholly ferritic ductile iron. The presence of combined carbon will tend to increase these values, particularly in the low-temperature range, so that from this point of view they are minimum values.

Education

The Creative Engineer, by J. E. Arnold, Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1955 ASME Diamond Jubilee Annual Meeting paper No. **55—A-163** (multilithographed; available to Oct. 1, 1956).

THIS paper on the creative engineer is based on the hypothesis that all people have a definite potential for creative activity, and that this potential can be realized through training and exercise. Some of the mental and emotional attributes of the creative personality are discussed. Mention is also made of some of the blocks that inhibit creative activity, along with suggestions for personal development and the management of creative personnel.

Evaluation, Distribution, and Training of Creative Men, by J. A. Anderson, General Motors Corporation, Flint, Mich. 1955 ASME Diamond Jubilee Annual Meeting paper No. **55—A-211** (multilithographed; available to Oct. 1, 1956).

ACCORDING to this paper, a great cost to an organization are the losses that occur because of a lack of creativity—or a lack of the use of creativity.

Such losses occur through ideas that are not thought of, through misplacement or poor supervision of creative people, and through a lack of training and identification.

Because of this, the AC Spark Plug Division is carrying on an extensive program in the field of testing for creativity, in the training and developing, and in placement.

Mechanical Pressure Elements

Recent Research on Flat Diaphragms and Circular Plates With Particular Reference to Instrument Applications, by A. M. Wahl, Fellow ASME, Westinghouse Research Laboratories, Pittsburgh, Pa. 1955 ASME Diamond Jubilee Annual Meeting paper No. **55—A-116** (multilithographed; to be published in Trans. ASME; available to Oct. 1, 1956).

A DISCUSSION and literature survey of recent theoretical and experimental developments relating to flat plates and diaphragms is given, with particular reference to applications in pressure-measuring instruments.

Developments discussed include: Effects of large deflections; initially buckled diaphragms; plates subject to plastic flow; analysis of temperature and acceleration effects in diaphragms for pressure measurement.

Some discussion of instruments utilizing flat or nearly flat diaphragms is given and an attempt is made to indicate possible fruitful avenues of future research in the diaphragm field.

Corrugated Metal Diaphragm Performance, by A. V. Kankel and D. C. Whitten, The Bristol Company, Waterbury, Conn. 1955 ASME Diamond Jubilee Annual Meeting paper No. **55—A-115** (multilithographed; available to Oct. 1, 1956).

A PROPERLY designed corrugated metal diaphragm is an excellent pressure-measuring device. Generally the corrugations are concentric, although radial corrugations, or ribs, are sometimes used if a particularly rigid diaphragm is required. The corrugations are usually made triangular, trapezoidal, or arc-shaped. The information presented in this paper was all obtained with diaphragms having concentric arc-shaped corrugations.

Diaphragm design is largely an empirical process. There have been a number of papers dealing with the problem, some from the theoretical and some from

the practical point of view, but the problem is so complex that we are far from a complete solution. The approximate effect on deflection of changes in diameter, thickness, number of corrugations, and corrugation depth is known. A recent National Bureau of Standards report also shows the effect of these variables on linearity.

This paper presents additional data showing the effect of profile variables on diaphragm performance. The aim is not to develop formulas but rather to report some practical design information. The results were obtained by systematically changing one variable at a time and noting the effect on linearity and deflection.

Design of Corrugated Diaphragms, by J. A. Haringx, Mem. ASME, Philips Research Laboratories, Eindhoven, The Netherlands. 1955 ASME Diamond Jubilee Annual Meeting paper No. **55—A-112** (multilithographed; available to Oct. 1, 1956).

THREE previous papers by the author set forth methods of calculating the rigidity of corrugated diaphragms, the stresses in the sheet material, and the nonlinearity of the relation between load and deflection. As a further step, the introduction of a few simplifying restrictions having no fundamental effect on the problem leads to the conception of a chart giving at once the dimensions a diaphragm must have so as to conform to specific requirements. An example is included by way of illustration.

Investigation of the Properties of Corrugated Diaphragms, by W. A. Wildhack, R. F. Dressler, and E. C. Lloyd, Mem. ASME, National Bureau of Standards, Washington, D. C. 1955 ASME Diamond Jubilee Annual Meeting paper No. **55—A-181** (multilithographed; to be published in Trans. ASME; available to Oct. 1, 1956).

THE pressure-deflection characteristics of corrugated diaphragms are correlated by methods of dimensional analysis. Experimental results for various sizes, materials, thicknesses, and shapes of diaphragms indicate that the performance for diaphragms of any given shape may be computed from a dimensionless formula derived from experimental data on other diaphragms of that shape. Linear shell equations are derived for combined bending and stretching effects with lateral loading terms for rotationally symmetrical shells in appropriate independent and dependent variations suitable for complicated meridial shapes, and with boundary conditions associated with practical diaphragm applications. The method used for solving this system of equations on an electronic digital computer is described and numerical solutions are presented for a specific diaphragm subject to uniform pressure loading. Suggestions are presented for future research, both theoretical and experimental, on diaphragm properties and performance.

A Bibliography on Diaphragms and Aneroids, by G. H. Lee, Mem. ASME, L. M. Van der Pyl, Mem. ASME, Rockwell Manufacturing Company, Pittsburgh, Pa. 1955 ASME Diamond Jubilee Annual Meeting paper No. **55—A-180** (multilithographed; available to Oct. 1, 1956).

THE authors believe that this Bibliography includes all the available published data on diaphragms and aneroids up to the end of 1954. The search was conducted by the authors and the annotation was performed by Lyman M. Van der Pyl, Dr. George H. Lee, and Lyman Cook.

Applied Mechanics

Some Dynamic Properties of Oil-Film Journal Bearings With Reference to the Unbalance Vibration of Rotors, by A. C. Hagg, Mem. ASME, and G. O. Sankey, Westinghouse Research Laboratories, East Pittsburgh, Pa. 1955 ASME Diamond Jubilee Annual Meeting paper No. **55—A-45** (in type; to be published in *Journal of Applied Mechanics;* available to Oct. 1, 1956).

SOME dynamic properties of oil films have been determined experimentally and their significance in the problem of unbalance vibration and critical speeds of rotor systems is illustrated by an example. It is shown that oil films have an important role in the unbalance-vibration behavior of rotor systems, particularly the vibration magnification at resonance.

A Method for Calculating Stress-Concentration Factors, by M. Hetenyi, Mem. ASME, The Technological Institute, Northwestern University, Evanston, Ill., and T. D. Liu, California Research Corporation, La Habra, Calif. 1955 ASME Diamond Jubilee Annual Meeting paper No. **55—A-81** (in type; to be published in *Journal of Applied Mechanics;* available to Oct. 1, 1956).

IT IS shown in this paper that along the root sections of filleted or notched bars there is a rapid rise in the transmitted shearing forces, and this may be regarded as the principal reason for the occurrence of stress peaks under these circumstances. By making a few assumptions concerning the distribution of these shear loads, the stress-concentration factors can be calculated with satisfactory accuracy for such cases which have been heretofore analytically intractable.

Fluid Meters

A Practical Pulsation Threshold for Flowmeters, by V. P. Head, Mem. ASME, Fischer & Porter Company, Hatboro, Pa., 1955 ASME Diamond Jubilee Annual Meeting paper No. **55—A-188** (multilithographed; to be published in Trans. ASME; available to Oct. 1, 1956).

PULSATION intensity, Γ, is defined as the ratio of extreme flow variation to average flow. An intensity $\Gamma = 0.1$ is recommended as a practical pulsation threshold below which the performance of all types of flowmeters will differ negligibly from the mathematical ideal of steady flow.

An equation suitable for estimating the error range at various intensities is presented, and the problems of correlation of attenuator performance and meter response are considered.

Pulsation Errors in Manometer Gages, by T. J. Williams, University College of Swansea, Swansea, Wales. 1955 ASME Diamond Jubilee Annual Meeting paper No. **55—A-92** (multilithographed; to be published in Trans. ASME; available to Oct. 1, 1956).

IT IS known that manometer gages of conventional design are subject to errors when the gas-pressure differential is pulsating. In this paper various factors contributing to the production of such errors are analyzed and the requirements for their elimination established. A differential manometer capable of indicating the true time-mean of a pulsating head is described.

Aviation

Air Freight—A Blueprint for 1956, by J. C. Emery, Emery Air Freight Corporation, New York, N. Y. 1955 ASME Diamond Jubilee Annual Meeting paper No. **55—A-86** (multilithographed; available to Oct. 1, 1956).

ACCORDING to this paper, air-freight selling in 1965 must have a quality not previously characteristic of carrier sales departments. It must be selling based on knowledge and the application of that knowledge in a myriad of production and distribution situations. It must be selling that recognizes air freight as only one of a broad array of excellent transportation media—water, rail, and

highway—with which this nation is blessed and that works toward the goal of bringing air freight into its proper place in the network. Backed by air-carrier management support and operating performance, this kind of selling cannot fail.

The time has come to initial the air-freight blueprint for 1965 and to pass it to the panel for review for correction of errors.

Steam Power Generation

A System of Charging for Steam in Industrial Plants With Power Generation, by L. J. Sforzini, Mem. ASME, and A. C. Winslow, Jr., Eastman Kodak Company, Rochester, N. Y. 1955 ASME Diamond Jubilee Annual Meeting paper No. **55—A-54** (multilithographed; available to Oct. 1, 1956).

INDUSTRIAL plants with both steam loads and power services, the latter including electrical generation and in many instances also substantial amounts of mechanical power in the form of steam drives for refrigeration, compressed air, water pumping, etc., have a problem in determining how to collect and equitably allocate the charges for steam. Any system to meet requirements must be able to meet two fundamental conditions: (*a*) The system must accurately reflect the over-all results of operation of all power or utilities services, so as to permit checking and controlling costs; (*b*) it must accurately distribute the cost of all services to products at the various stages of manufacture.

The system developed in this paper by the authors may be described as a "Btu System."

This Btu system, it is believed, provides a method of equitably subdividing the steam charges to a multiplicity of power services in industrial plants with power generation and/or mechanical drives, and that it provides a method of readily checking and controlling costs. The resulting costs and/or fuel use rate can readily be compared to other plants. Further, once the system is worked up its use can be routine, provided corrections are made when equipment or other changes are made.

Aqueous Homogeneous Reactors for Producing Central-Station Power, by R. B. Briggs, Oak Ridge National Laboratory, Oak Ridge, Tenn. 1955 ASME Diamond Jubilee Annual Meeting paper No. **55—A-219** (multilithographed; available to Oct. 1, 1956).

FOR many years aqueous homogeneous reactors have been among the most promising "long-range prospects" for producing economical central-station power. Among the many attractive features which they derive from the use of aqueous-fluid fuel systems are excellent fuel economy, adaptability to continuous fuel purification, excellent nuclear stability, and simple mechanical design. Exploitation of the advantages has been difficult because of problems of corrosion, fuel chemistry, containment of radioactive fluids at high temperature and pressure, and maintenance of radioactive equipment.

Since 1950 the technology of the aqueous homogeneous systems has been under development at the Oak Ridge National Laboratory. The Homogeneous Reactor Experiment was operated successfully in 1953 to demonstrate the nuclear stability and, to some extent, the chemical and engineering feasibility of this type of reactor when operated at a high enough temperature for power applications. The Homogeneous Reactor test is being constructed as a pilot plant for developing power-reactor systems and will be completed in 1956. Recently a major equipment manufacturer and a large power company revealed plans for participating in the development of the technology with the objective of constructing a large homogeneous reactor power station to produce competitive power in 1962.

General technology of aqueous homogeneous reactors for central-station application is presented in this paper. Problems of design and operation of circulating fuel reactors are considered in the discussion of the design of a 100-mw power station.

Metals Engineering

On the Applicability of Notch Tensile-Test Data to Strength Criteria in Engineering Design, by J. D. Lubahn, Mem. ASME, General Electric Research Laboratory, Schenectady, N. Y. 1955 ASME Diamond Jubilee Annual Meeting paper No. **55—A-149** (multilithographed; to be published in Trans. ASME; available to Oct. 1, 1956).

IN NOTCH tensile tests, as in any test to fracture, the results of the test are governed by two phenomena, i.e., the initiation of a crack, and separation of the specimen due to the propagation of that crack. The first of these phenomena is much better understood than the second; and most of the features of notch tensile testing which make the results intelligible are connected with the "ductility," or the local strain at crack initiation. The nature of the crack propagation, on the other hand, is almost completely obscure; and consequently, although crack propagation is exceedingly important in many applications, such as the failure of welded ships, this aspect of fracturing will not be treated in the following.

There has been very little change in the state of knowledge of notch tensile behavior since last reviewed, regarding either new experimental results or general concepts. It is not the purpose of this paper to summarize again the scientific status of the subject, and consequently only those few new experimental facts subsequent to the earlier survey are discussed. However, an effort is made to review the state of affairs of notch tensile testing from an engineering viewpoint, inquiring in particular as to what degree of applicability the current scientific knowledge has to engineering problems. The unanswered question of how to design a part in such a way as to avoid fracturing in service is one of the most important engineering problems of today.

Effect of Surface Finish on the Fatigue Strength of Titanium Alloys RC 130B and Ti 140A, by G. M. Sinclair, H. T. Corten, Assoc. Mem. ASME, and T. J. Dolan, Mem. ASME, University of Illinois, Urbana, Ill. 1955 ASME Diamond Jubilee Annual Meeting paper No. **55—A-197** (multilithographed; to be published in Trans. ASME; available to Oct. 1, 1956).

AN INVESTIGATION was made of the effect of various surface-finishing operations on the fatigue strength of two titanium alloys, RC 130B and Ti 140A. The types of finish studied included rough-machined, machined and mechanically polished, cold-rolled, electropolished, and ground surfaces. Through the use of microhardness measuring techniques it was found that the different finishing methods introduced varying degrees and varying depths of cold work in the surface layers of the metal. Cold-rolling produced the highest hardness in the surface layer while grinding gave the lowest value; in one case the ground surface appeared to be slightly softer than the inner-core metal.

In general, the fatigue strength for lifetimes exceeding 2×10^7 cycles was found to vary according to the hardness of the surface layer with the highest hardness corresponding to the greatest fatigue strength. Roughness of the surface was also found to influence fatigue strength but to a much lesser degree than hardness. As a first approximation the relationship between surface hardness, surface roughness, and fatigue strength could be expressed by an equation of the form $Z = KX^{-a}Y^{b}$ where

Z is fatigue limit, X is surface roughness, Y is hardness, and K, a, and b are constants of the material. Data from the present study were evaluated in terms of this equation and the results are presented in the form of a nomograph. Results of tests made on notched specimens appear to indicate that titanium is less notch-sensitive in fatigue than was previously reported. Early reports of extreme notch sensitivity may have resulted from comparisons made between notched and smooth specimens having quite different surface preparations in the test section.

Certain Departures From Plastic Ideality at Small Strains, by H. A. Lequear and J. D. Lubahn, Mem. ASME, General Electric Company, Schenectady, N. Y. 1955 Diamond Jubilee Annual Meeting paper No. 55—A-151 (multilithographed; available to Oct. 1, 1956).

Room-temperature experiments involving strains up to about 1 per cent have been performed on OFHC copper. These experiments show that the results of creep tests and tensile tests can be related, within certain limitations, in terms of the rate sensitivity. Rate sensitivity is the increase in stress required to cause a certain increase in strain rate at a given strain.

The foregoing relation between creep and tensile behaviors is a consequence of the concept that plastic-deformation behavior depends only on current conditions, and not on the prior history. This relation is restricted to isothermal conditions and monotonic loading (increasing or constant, but not decreasing, load). Room-temperature creep curves are essentially straight lines on log-log paper. Extrapolation of these curves indicates that there would not be much more creep in long-time service at room temperature than in a short-time laboratory test.

Creep Damage in a Cr-MO-V Steel as Measured by Retained Stress-Rupture Properties, by M. H. Jones and W. F. Brown, Jr., Lewis Flight Propulsion Laboratory, Cleveland, Ohio, and D. P. Newman, Naval Ordnance Testing Station, Inyokern, China Lake, Calif. 1955 ASME Diamond Jubilee Annual Meeting paper No. 55—A-175 (multilithographed; available to Oct. 1, 1956).

It is well known that a material subjected to progressive creep eventually fractures at a time determined by the applied stress and temperature. However, the processes which exhaust the metal ductility in creep are very poorly understood. Until these processes are clearly defined it is not possible to arrive at a satisfactory fracture theory for creep nor is it possible to predict intelligently the effects of creep history on the rupture life.

The object of the present investigation is to reveal the influence of the following variables on creep damage: (*a*) Fraction of life exhausted by creep, (*b*) creep-stress levels resulting in widely different ductilities, (*c*) combined effects of creep strain and time, and (*d*) the influence of reheat-treatment. In addition, an attempt is made to show the relation between notch sensitivity and creep damage and to discuss a mechanism to explain both these phenomena.

Production Engineering

Foundry Automation and the Shell-Molding Process, by J. Sutherland, Foundry Equipment Division, Link-Belt Company, Chicago, Ill. 1955 ASME Diamond Jubilee Annual Meeting paper No. 55—A-162 (multilithographed; available to Oct. 1, 1956).

The shell-molding process represents to the foundry industry a step closer to the automatic or push-button foundry. The process, which consists of making thin resin-bonded shells, provides comparatively light molds and a subsequent reduction in material requirements, simplifying the design of automatic equipment. The foundry industry, through mechanization, has been gradually approaching automation during the past 20 or 25 years, and the shell-molding process will greatly advance this degree of automation.

Heat Transfer

An Investigation of Convection Heat Transfer in a Porous Medium, by S. M. Marco, Mem. ASME, and L. S. Han, Mem. ASME, Ohio State University, Columbus, Ohio. 1955 ASME Diamond Jubilee Annual Meeting paper No. 55—A-104 (multilithographed; available to Oct. 1, 1956).

The complex configuration of any porous medium precludes the possibility of using an analytical method such as has produced satisfactory results in other phases of free and forced convection which involved relatively simple configurations. Consequently, an alternate approach, based on dimensional analysis and experimental correlation, is necessitated.

For the purpose of achieving generality, heat-transfer correlations must not be governed by the particular units employed. This then points to the formation of dimensionless variables as the working parameters, viz., Prandtl, Reynolds, and Nusselt numbers. While the first variable describes the fluid properties, Reynolds and Nusselt numbers are indexes of the flow and thermal quantities. Both parameters contain a linear dimension which "characterizes" the geometry of the physical system involved. Whereas this dimension is easily determined for the more conventional heat-transfer systems, its determination represents a major task for porous media because of geometrical complexity. This complex nature of the porous structure also has made useless the concept of a film heat-transfer coefficient which can be computed, since in porous media it is impossible to measure the area exposed to the heat-exchange fluid.

The primary purpose of this investigation was to produce results of practical and general utility. It was therefore desirable to develop methods which make possible the use of the experimental data to predict the quantity or rate of heat transfer. One convenient concept was a heat-transfer coefficient defined as the rate of heat transfer per unit volume (gross) per unit temperature difference. If empirical results can be correlated with such a modified heat-transfer coefficient, the information can be useful for heat-transfer calculations for other porous media in which the volume of the porous material can be measured.

Liquid-Droplet Heating and Evaporation in a High-Temperature Gas Stream, by J. W. Rizika, Assoc. Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1955 ASME Diamond Jubilee Annual Meeting paper No. 55—A-154 (multilithographed; available to Oct. 1, 1956).

This paper is concerned with the analysis of the heating and evaporating processes which occur when a liquid droplet or droplets are suddenly injected into a moving, high-temperature gas stream.

Essentially a refinement and an extension of an earlier work, this analysis is concerned with both the process of adding sensible heat to the liquid droplet prior to the commencement of droplet evaporating and the processes of evaporation and addition of sensible heat to the droplet vapor which has evaporated. The analysis of the latter process differs from that presented in the earlier work in that fewer simplifying assumptions are made. In addition, a means of estimating an average droplet diameter resulting from a liquid jet being sprayed into a moving gas stream is discussed in the present paper. Practically, the analysis presented herein enables the pre-

diction of the channel length required to satisfactorily cool gases in the low and medium-temperature range (hundreds of deg F) as well as in the high-temperature range (thousands of deg F).

Flow Sampling and Discharge Measurement in Geothermal Bores, by C. J. Banwell, Dominion Physical Laboratory, Lower Hutt, New Zealand. 1955 ASME Diamond Jubilee Annual Meeting paper No. 55—A-97 (multilithographed; available to Oct. 1, 1956).

THE development of a sampler for measuring the heat and mass discharges of steam bores is described, and the results obtained in a number of test runs are compared with those given by full-scale separating and metering equipment. The sampler also has been used to investigate the flow distribution across a free-steam water jet, and the results are shown in graphical form, and some of their implications discussed.

Temperature and Velocity Distribution in Turbulent Flow of Mercury, by B. H. Amstead, Assoc. Mem. ASME, H. E. Brown, and B. E. Short, Fellow ASME, The University of Texas, Austin, Texas. 1955 ASME Diamond Jubilee Annual Meeting paper No. 55—A-107 (multilithographed; available to Oct. 1, 1956).

THIS paper presents results of an investigation made with mercury flowing turbulently in a circular pipe under isothermal and nonisothermal conditions. Velocity and temperature traverses were made in a water-cooled, $1^1/_2$ in. nickel-pipe test section at Reynolds moduli between 218,500 and 811,500.

Experimental heat-transfer results are given and compared to those obtained by other investigators. Data are presented confirming that there are locations in any fluid stream where average temperatures and velocities can be obtained by single probing devices, thus eliminating the need for complete traverses to obtain average values.

ASME Transactions

for March, 1956

THE March, 1956, issue of the Transactions of the ASME, which is the *Journal of Applied Mechanics* (available at $1 per copy to ASME members; $1.50 to nonmembers) contains the following:

Technical Papers

Affine Transformation for Orthotropic Plane Stress and Plane Strain, by H. A. Lang.

The Nonlinear Bending of Thin Circular Rods, by H. D. Conway. (55—A-24)

Asymmetrical Bending of a Cylindrically Aeolotropic Tapered Disk, by E. S. Baclig and H. D. Conway. (55—A-20)

Rigidity of Orthogonally Stiffened Plates, by N. J. Huffington, Jr. (55—A-12)

Large Deflections of Elliptical Plates, by N. A. Weil and N. M. Newmark. (55—A-2)

Plastic Buckling of Plates, by P. P. Bijlaard. (55—A-8)

Bending Creep and Its Application to Beam-Columns, by L. W. Hu and N. H. Triner. (55—A-21)

Combined Stress Tests in Plasticity, by Aris Phillips and Lloyd Kaechele. (55—A-15)

The Load-Carrying Capacity of Circular Plates at Large Deflection, by E. T. Onat and R. M. Haythornthwaite. (55—A-14)

Plastic Deformation in a Deeply Notched Bar, by L. Garr, E. H. Lee, and A. J. Wang. (55—A-23)

On Axially Symmetric Bending of Nearly Cylindrical Shells, by R. A. Clark and E. Reissner. (55—A-18)

Analysis of Short Thin Axisymmetrical Shells Under Axisymmetrical Edge Loading, by G. Horvay, C. Linkous, and J. S. Born. (55—A-3)

Displacements in an Elastic-Plastic Cylindrical Shell, by P. G. Hodge, Jr. (55—A-4)

Stress Concentration Caused by Multiple Punches and Cracks, by Michael Sadowsky. (55—A-16)

The Stress Distribution in a Strip Loaded in Tension by Means of a Central Pin, by P. S. Theocaris. (55—A-34)

Solutions of the Equations of Elasticity for Porous Materials, by M. A. Biot. (55—A-7)

Natural Frequencies of Continuous Plates, by A. S. Veletsos and N. M. Newmark. (55—A-11)

Bending Vibrations of Variable Section Beams, by E. T. Cranch and Alfred A. Adler. (55—A-19)

Matrix Solution for Vibration of Nonuniform Disks, by F. F. Ehrich. (55—A-17)

Studies in Dynamic Photoelasticity, by M. M. Frocht and P. D. Flynn. (55—A-1)

The Effect of the Earth's Rotation on Laminar Flow in Pipes, by G. S. Benton. (55—A-9)

Flow of Gas Through Porous Media, by J. S. Aronofsky and J. D. Porter. (55—A-13)

Discussion

Discussion on previously published papers by W. N. Findley and J. J. Poczatek; David Sinclair; M. M. Frocht and Roscoe Guernsey, Jr.; G. A. Zizicas; M. C. Junger; R. T. Hinkle, C. Ip, and J. S. Frame; E. J. Scott and D. R. Carver; H. Ōkubo and S. Satō; H. Becker; R. S. Brand; E. A. Davis; I. Cornet and R. C. Grassi; J. Denavit and R. S. Hartenberg; F. M. Lewis; N. J. Hoff; H. G. Hopkins and W. Prager; F. A. McClintock; C. T. Wang, R. J. Vaccaro, and D. F. De Santo; B. W. Shaffer and R. N. House, Jr.; B. T. Plymale and R. Goodstein; and M. Morduchow, S. W. Yuan, and H. Reissner.

Book Reviews

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Comments on Papers

Including Letters From Readers on Miscellaneous Subjects

Warning to Professional Engineers

Comment by Lowell C. Cockel, Jr.[1]

MR. VEATCH[2] is to be congratulated for his timely, important contribution. Naturally we like to approach a subject carefully, and it seems particularly important here that the issues remain quite vigorously clear. Further, it seems that remedial action should be formulated and carried out with equal care and vigor.

Perhaps in this case we should use the term "professional engineer," so well defined by Dr. Stratton in the same issue, as synonymous of and interchangeable with "consulting engineer." The qualities of a professional engineer, difficult of definition, are to an important degree related to care for the interests of those he serves. He does not individually prevail without justice. And all the history of mankind teaches that there is no justice without law, no law without enforcement. Neither does the professional engineer of himself perpetuate or improve in quality without an atmosphere favorable to his refinement.

It must be assumed that those who require the services of a professional engineer will be incompetent to judge the utility of such service. It also must be assumed that they cannot differentiate among imitations and gradations of quality. It is then impossible for a professional engineer consistently to surmount offers replete with dissimulation. He also is at a disadvantage if he must compete with engineering offered in combination with other items. Those who would confound him must be assumed to know this.

From the foregoing considerations it seems clear that professional engineers must be the law-givers. Their law must be conceived and executed to show their position clearly to the public in a manner beyond reproach and with suitable dignity. Further, it seems clearly their duty to extirpate violators faithfully. If the violators can succeed by avoiding the mention of engineering or by sharp practice, injustice will be done and the professional engineer will have failed his duty.

The present situation seems to provide considerable evidence that the professional-engineer's law and enforcement are inadequate. Two frameworks are presently available for immediate rectifying action: (1) The several professional societies and associations, and (2) the basis for licensing bodies established by the states. Let us carefully and vigorously continue to define the problem, improve solutions, perfect means for enforcement, and carry them out.

At the same time we must be carefully just in our contacts with our neighbors. It seems particularly important to see that due consideration is given to reputable contractors and fabricators. Each of these performs an important service, but it seems distinct from conception and design. Further, it seems important to respect the place of technical people other than professional engineers. Professional engineers may rise from such ranks, but they also contain those who will not. Their problems also seem distinct.

[1] Mechanical Engineer, Sierra Madre, Calif. Assoc. Mem. ASME.

[2] "Dangers Ahead for the Engineering Profession," by N. T. Veatch, MECHANICAL ENGINEERING, vol. 77, November, 1955, pp. 971–974.

Who's Who in Engineering

Comment by H. J. Hirschhorn[3]

THIS study[4] is of interest to all graduate engineers as it poses the question of the rating of colleges of engineering. The authors have used two methods: (1) The total number of graduates who made "Who's Who," and (2) the percentage of graduates who made "Who's Who." It would be interesting to compare these ratings with other methods. The following come to mind readily:

(*a*) Ratio of students to faculty.

(*b*) Ratio of graduate to undergraduate students at that college.

(*c*) Percentage of undergraduates who obtained MS degrees at any other college.

(*d*) Percentage of undergraduates who obtained PhD degrees at other colleges.

(*e*) Average number of undergraduates in engineering.

(*f*) Percentage of BS graduates who obtained PE licenses.

Statistical methods of correlation and regression between these would not be too difficult to apply, and might have unexpected results.

[3] Design Engineer, United States Gypsum Company, Chicago, Ill. Associate Mem. ASME.

[4] "A Study of College Graduates in the 1954 Edition of 'Who's Who in Engineering,'" by C. J. Baer, MECHANICAL ENGINEERING, vol. 77, October, 1955, pp. 890–892.

Comment by C. R. Soderberg[5]

In Table 2 of the article,[4] M.I.T. is listed as having 27,088 BS graduates from its inception to June, 1954. I should like to point out that, of those, only 22,877 represent the degrees in engineering, which will change the percentage from 3.44 to 4.06. I wish to emphasize in addition that the inclusion of deceased alumni places the older schools in an abnormally unfair position. For M.I.T., for example, it is estimated that there are now 18,300 living alumni with BS degrees in engineering. The number of people listed in "Who's Who in Engineering," 930, represents approximately 5 per cent of this number.

Author's Closure

Each of the six proposals made by Mr. Hirschhorn would, if developed, provide interesting and useful information. The ratio of students to faculty, for instance, would provide a minimal standard which could be used by the Engineers' Council for Professional Development in its accreditation program, and might do as much for undergraduate education as the newly adopted curricula restrictions.

The median undergraduate enrollment figure for 150 accredited engineering schools was 747 students in the fall of 1954. The mean figure, which is not as easily available, would have been somewhat higher.

In reply to Dean Soderberg, it should be stated that the Massachusetts Institute of Technology was requested by letter, dated March 23, 1955, to supply (*a*) the number of living engineering

[5] Dean, School of Engineering, Massachusetts Institute of Technology, Cambridge, Mass. Fellow ASME.

Table 1

College	Total BS grads through June, 1954	No. graduates in Who's Who	Per cent listed
South Dakota School of Mines	1843	153	8.30
Wisconsin University	10880	350	3.22
Delaware University	733	23	3.14
Pratt Institute	1440	44	3.05
Lehigh University	6000 est.	172	2.87
California University	12136	334	2.75
Lafayette College	2897	78	2.70
Colorado University	6813	178	2.61
Michigan State	5877	90	1.53
Illinois Institute of Technology	10014	144	1.44

graduates, or (*b*) the total number of BS engineering graduates of that institution through 1954. It is regrettable that the official custodian of the records, the registrar, did not transmit the desired information.

Information on engineering enrollments for ten of the schools was received too late to be included in Table 2 of the original article. Their enrollments and percentages of graduates listed in "Who's Who in Engineering" are shown in Table 1.

The South Dakota School of Mines and Technology had the highest percentage of all institutions for which we have data, including those schools listed in the original report.

Charles J. Baer.[6]

[6] Assistant to the Dean, University of Kansas, School of Engineering and Architecture, Lawrence, Kan.

Reviews of Books

And Notes on Books Received in Engineering Societies Library

Solar-Energy Research

SOLAR ENERGY RESEARCH. Farrington Daniels and John A. Duffie, editors. The University of Wisconsin Press, Madison, Wis., 1955. Cloth, 6 × 9¼ in., figs., tables, bibliography, index, plates, xv and 290 pp., $4.

Reviewed by F. C. Hooper[1]

THIS book has been prepared by the editors largely from information initially presented at the Wisconsin symposium on solar energy held in September, 1953. Except for introductory and closing remarks it is composed of articles prepared by 31 different authors, most of whom attended the conference and subsequently set down in varying degrees of detail the substance of their contributions to that meeting.

The scope of the topics considered covers the whole spectrum of interest in solar energy. This includes work directed toward the possible space-heating, electric-power generation, solar-water distillation, and solar-furnace applications, and discussions on the corresponding fundamental studies of solar-heat energy collection, electrochemical, photochemical, and photosynthetic processes.

Such broad coverage does, of course, restrict the amount of information presented on any one topic. In consequence, to a worker in any specific field of solar research the book is unlikely to provide much new specific information in his own field. It would, however, reveal to him the general outlines of the work being carried out in parallel fields and possibly lead him to a broader appreciation of the present status of solar-energy utilization research.

The material has been organized, more or less logically, into ten sections. This should facilitate use of the book as a general reference, possibly the use to which this work is best-suited. An excellent bibliography covering publications up to 1954 has been included, together with an adequate index to both authors and topics. There is also appended a survey of some 240 U. S. Patents relating to the use of solar energy. These date from 1852 to the present and are of possible legal and of certain historic interest.

It is probably fair to say that this work is something more than the usual proceedings of a scientific meeting, but certainly lacks the continuity, organization, or completeness which is associated with a standard reference work.

[1] Assistant Professor of Mechanical Engineering, University of Toronto, Toronto, Ont., Can.

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Books Received in Library

ASTM SPECIFICATIONS FOR STEEL PIPING MATERIALS. American Society for Testing Materials, Philadelphia, Pa., 1955. 425 p., 9 × 6 in., paper. $4. (Members $3.). These specifications cover pipes used to convey liquids, vapors, and gases at normal and elevated temperatures; still tubes for refinery service; tubes for heat exchangers, condensers, boilers, and superheaters; and materials used in pipe and related installations. Forty-seven of the fifty-eight standards in this compilation were not included in the 1954 issue.

ASTM STANDARDS ON PLASTICS. American Society for Testing Materials, Philadelphia, Pa., 1955. 790 p., 9 × 6 in., paper. $5.75. This is a new edition of a special compilation of all the specifications, methods of test, definitions, etc., relating to plastics. Of the 143 standards included, 4 are new and 41 have been revised, reaffirmed, or advanced from tentative status since publication of the previous edition in 1954.

BERECHNUNG UND GESTALTUNG VON GUMMIFEDERN. By E. F. Göbel. Second edition, 1955, Springer-Verlag, Berlin, Germany. 86 p. 6 × 9⅜ in., paper. 9 DM.

Rubber springs and other similar engineering uses of rubber are dealt with in this small book. Design calculations, construction de-

tails, practical applications, and testing methods are described and illustrated. There is a bibliography of German references of the past twenty years.

BIBLIOGRAPHICAL ABSTRACTS ON EVALUATION OF BRIGHTENING AGENTS FOR DETERGENTS USAGE. Prepared by L. E. Weeks (Special Technical Publication no. 177). 1955, American Society for Testing Materials, Philadelphia, Pa., 9 p., 6 × 9 in., paper. $1.50. Includes thirty-seven references covering instruments and methods for the measurement of brightness imparted to various types of fiber by agents in dyes or detergents. The references are listed by year (1943–1955), then by author or journal, and are indexed by author and subject.

DESIGN OF PIPING SYSTEMS. By The M. W. Kellogg Company. Second edition, 1956, John Wiley and Sons, Inc., New York, N. Y. 365 p., $8^3/_4 \times 11^1/_4$ in., bound. $15. Specific design procedures for entire piping systems and individual components are presented, along with the background information needed for applying analytical results and handling special situations met in designing critical piping. The opening chapters deal with physics of materials, the capacity of piping to carry various loadings, and local flexibility and stress intensification. In the revision, the chapters on simplified methods of flexibility analysis and the Kellogg general analytical method have been greatly enlarged, and new chapters have been added on expansion joints, supports, and vibration. Bibliographies and an appendix containing charts and tables are included.

ELEVATED-TEMPERATURE PROPERTIES OF CARBON STEELS. (Special Technical Properties, no. 180). American Society for Testing Materials, Philadelphia, Pa., 1955. 63 p., $11 \times 8^1/_2$ in., paper. $3.75. Data for tensile and yield strength, elongation and reduction of area, stresses for creep rates of 0.0001 and 0.00001 per cent per hour, and rupture strengths for 100, 1000, 10,000, and 100,000 hours are given for the following: killed carbon steel (0.18 to 0.24C); ASTM A201 Grade B plant steel (0.24C max); ASTM A106 Grade B pipe steel (0.30C max); killed carbon steel (0.27 to 0.58C); aluminum killed steel; open steel (rimmed or capped); and miscellaneous carbon steels. The information is presented in graphical form and supplemented by data sheets.

FOUNDATIONS OF PRODUCTIVITY ANALYSIS. By Bela Gold. University of Pittsburgh Press, Pittsburgh, Pa., 1955. 303 p., $8^3/_4 \times 5^1/_2$ in., bound. $5. The purpose of this monograph is to develop effective methods for the analysis and control by management of changes in industrial productivity. The five parts of the study cover objectives and methods of analyzing productivity; the component of productivity; factors involved in adjustments in productivity; the effects of various forms of productivity adjustments; and cost and other objectives as guides for management in the formulation of policy in regard to productivity adjustments.

FUNDAMENTALS OF PRESS TOOL DESIGN. By W. F. Walker. Philosophical Library, Inc., New York, N. Y., 1955. 152 p., $8^3/_4 \times 5^3/_4$ in., bound. $4.75. This book gives concise practical information on the design of tools for over twenty different operations performed by the more commonly used types of press tools. The operations treated include blanking, piercing, clipping, shaving, notching, bending, drawing, cupping, and so on, with variations of each operation illustrated by a series of drawings. Basic information on the construction and uses of the various types of tools is included, and the calculation of blank sizes and selection of tool materials are briefly considered.

HANDBUCH DER WERKSTOFFPRÜFUNG. Vol. 2: Die Prüfung der metallischen Werkstoffe. Edited by E. Siebel. Second edition, 1955, Springer-Verlag, Berlin, Germany. 754 p., $6^7/_8 \times 9^7/_8$ in., bound. 118.50 DM. This second volume of a five-volume set on materials testing covers the testing of metallic materials. The several sections cover the equipment and procedures for the following testing methods: tension, impact, vibration, hardness, and various special industrial operations. The testing of wire, bearing materials, welds, wear, and other specific materials and effects are also dealt with. There are numerous bibliographic footnotes.

LOW TEMPERATURE PHYSICS. By L. C. Jackson. Fourth edition, 1955, John Wiley and Sons, Inc., New York, N. Y. 158 p., $4^1/_4 \times 6^3/_8$ in., bound. $2. A concise survey of the general principles of selected aspects including the production and measurements of low temperatures, liquid and solid helium, specific heats, electrical conductivity, and magnetism. A brief bibliography is supplied for those interested in more comprehensive studies of the subjects discussed.

MODERN PHYSICS. A Textbook for Engineer. By Robert L. Sproull. 1956, John Wiley and Sons, Inc., New York, N. Y. 491 p., $6 \times 9^1/_4$ in., bound. $7.75. An analytical introduction to physics and its applications, based on a course given to undergraduate students and engineers in industry. The opening chapters cover particles and their interactions, and the laws that govern the behavior of particles in atoms and nuclei. Quantum mechanics, introduced early in the book, is used throughout to provide explanations of such engineering problems as the operation of transistors, characteristics of electron tubes, and nuclear reactors. Whenever possible the experiments of modern physics are applied to engineering instrumentation and to the understanding of processes and materials.

NUCLEAR MAGNETIC RESONANCE. By E. R. Andrew. Cambridge University Press, New York, N. Y., 1955. 265 p., $8^3/_4 \times 5^5/_8$ in., bound. $6.50. A comprehensive review covering basic theory, experimental methods, applications in the measurement of nuclear properties, and the properties and applications of the phenomenon in liquids and gases, nonmetallic solids, and metals. Some of the many applications discussed are the use of the resonance spectrum to reveal information on the structure of nonmetallic solids, to study the magnetic properties of ferromagnetic crystals, to provide information on the short-range order of alloys, and to discover defects in both metals and nonmetallic solids. A bibliography of over four-hundred references is included.

NUCLEAR RADIATION DETECTORS. By J. Sharpe. John Wiley & Sons, Inc., New York, N. Y., 1955. 184 p., $6^3/_4 \times 4^1/_4$ in., bound. $2.50. A brief summary of basic information intended for users and designers of detectors. The discussion covers the processes by which neutrons and electromagnetic radiation produce effective particles; the interaction of nuclear radiation with matter; detection media; the efficiency of detectors; scintillation counters; and ionization devices. References are listed after each chapter, and a general bibliography is appended.

PROFESSIONAL ENGINEERS EXAMINATIONS—QUESTIONS AND ANSWERS. By William S. LaLonde, Jr. 1956, McGraw-Hill Book Company, Inc., New York, N. Y., 462 p., $5^1/_2 \times 8^1/_4$ in., bound. $6.50. Eighty per cent of the 500 problems in this book have been taken from past examinations given in many states; the remainder have been added to give better coverage of some subjects. The questions have been selected to represent all the major phases of examinations for professional engineers and engineers-in-training, and the answers are given in the detailed form acceptable to examiners. General information on registration, experience, qualifications, and so on, is included in an introductory section.

DIE PUMPEN. By E. Fuchslocher and H. Schulz. Ninth edition, 1955, Springer-Verlag, Berlin, Germany, 188 p., $6^1/_4 \times 9^3/_8$ in., bound. 16.50 DM. A standard text covering the fundamental principles, design calculations, construction details, and examples of applications of centrifugal and reciprocating pumps. A final brief chapter discusses jet pumps and steam injectors.

REGELUNGSTECHNIK. By Georg Hutarew. 1955, Springer-Verlag, Berlin, Germany. 176 p., $6^1/_4 \times 9^1/_4$ in., bound. 21 DM. An introductory text in the field of mechanical control methods, including a detailed treatment of the regulation of hydraulic turbines. The treatment is sufficiently mathematical to cover the theory for the student as well as providing a practical approach for the engineer.

ROTORCRAFT. By R. N. Liptrot and J. D. Woods. Butterworths Scientific Publications, London, England, 1955. 161 p., $10 \times 6^1/_4$ in., bound. $5. A simple and practical explanation of the fundamentals of rotary-wing aircraft engineering, designed as a guide to the engineer in his daily work. Fairly extensive chapters are devoted to rotor aerodynamics, the articulated rotor, and control and stability; brief chapters to the description and operation of the helicopter, vibration and noise, design-study procedure, and the economics of the helicopter. A fully illustrated historical summary, a glossary, a list of specifications, a directory of manufacturers, and a bibliography are also included.

RUBBER RED BOOK, 1955–56 EDITION. Directory of the Rubber Industry. *Rubber Age*, New York, N. Y., 1955. 1249 p., $9^1/_4 \times 6^1/_4$ in., bound. $10. The new edition of this standard directory of the rubber industry supplies data on over 1400 manufacturers in the United States and Canada. The plants, executives, number of employees, and products of each company are indicated, and numerous supplementary listings—suppliers of rubber chemicals, synthetic-rubber manufacturers, scrap dealers, trade and technical organizations, and so on, are included. Other special sections are those devoted to educational courses in the field, rubber periodicals, and a who's who of the industry.

SELECTED PAPERS ON ENGINEERING MECHANICS. (A Tribute to Theodore von Kármán.) Edited by G. Gabrielli, F. N. Scheubel, and F. L. Wattendorf. 1955, Butterworths, London, England, 186 p., $5^3/_4 \times 8^3/_4$ in., bound. Available from Academic Press, Inc., New York, N. Y. $8. The subjects dealt with in the ten papers included are the following: Determining the wing area and its aspect ratio in aircraft design; the self-excited unsymmetrical gyroscope; the theory of rock breaking in mining and construction; three-dimensional flow in turbomachinery; semistatic pressure

exchangers; the effect of size and shape on fatigue strength; subsonic flow in a supersonic region; flow and heat exchange in blast-furnace stoves; laminarized aircraft; and problems of masses of fluids set in motion by a moving body. The latter paper uses as examples parachutes, balloons, and the rolling of a ship.

SPECIFICATIONS AND TESTS FOR ELECTRODEPOSITED METALLIC COATINGS. American Society for Testing Materials, Philadelphia, Pa., 1955. 96 p., 9 × 6 in., paper. $1.85 (ASTM members $1.40). The specifications included deal with coatings of zinc, cadmium, nickel-chromium, and lead on steel; nickel-chromium on copper and zinc; and chromate finishes on zinc coatings. Local thickness and other test methods are included, as are several recommended practices for chromium plating on steels and the preparation of various metals for plating.

STAHLLEICHTBAU VON MASCHINEN. By K. Bobek, A. Heiss, and F. Schmidt. Second edition, 1955, Springer-Verlag, Berlin, Germany, 183 p., 6 1/4 × 9 3/8 in., bound. 24 DM. The principles of light-steel construction in machines are reviewed, and applied to the design and construction of electric motors, machine tools, and internal-combustion engines. Methods of joining, strength characteristics of the materials and units, and other similar aspects are taken up in separate chapters, with many illustrative diagrams and photographs.

TEMPERATURE. Its Measurement and Control in Science and Industry. Vol. 2. Edited by H. C. Wolfe for the American Institute of Physics. 1955, Reinhold Publishing Corporation, New York, N. Y. 467 p., 6 1/4 × 9 1/4 in., bound. $12. The emphasis in the twenty-four papers contained in this volume is on the basic physics involved in temperature concepts and measurements. Included are discussions of temperature in very hot gases and in matter near absolute zero, standards and scales in use at present, the use of semiconductors and superconductors for measurement, and sound velocity as a measurement of gas temperature. Engineering aspects of the subject deal with standard and specialized methods of measurement, and with temperature measurement in steelmaking.

TEXTBOOK OF SOUND. By A. B. Wood. Third edition, 1955, The Macmillan Company, New York, N. Y. 610 p., 5 3/4 × 9 3/8 in., bound. $6.75. Dealing with vibrations of all frequencies, audible or otherwise, this book covers theory; vibrating systems and sources of sound; and sound transmission, reception, transformation, and measurement. It also includes a section on applications, including measurement of distance, acoustics of buildings, recording and reproduction, and musical instruments. The treatment is on the level of the engineering student, with footnote references to original papers provided for those who are interested in more detailed information.

THEORY OF HYDRODYNAMIC STABILITY. By C. C. Lin. Cambridge University Press, New York, N. Y., 1955. 155 p., 8 1/2 × 5 1/2 in., bound. $4.25. Limited mainly to the study of the stability of the motion of a homogenous viscous fluid with respect to infinitesimal disturbances, this study gives a reasonably detailed treatment of the Couette flow and the Poiseuille flow as central to the development of the general theory of hydrodynamic stability. Boundary layer over a flat plate and other nearly parallel flows are dealt with, and a chapter is devoted to examples of stability problems in astrophysics and geophysics. The last chapter discusses the basic mathematical theory underlying the analysis of the stability of parallel flow.

TORQUE CONVERTERS OR TRANSMISSIONS. By P. M. Heldt. Chilton Company, Philadelphia, Pa., fifth edition, 1955. 496 p., 8 3/4 × 5 1/2 in., bound. $8. In the present edition of this comprehensive treatment of the theory and practice of drives for internal-combustion engines, only minor changes have been made in the first nine chapters dealing with hand-operated transmissions. The remaining eleven chapters on automatic transmissions have been completely rewritten, giving greater space to transmissions comprised of a hydrodynamic torque converter and planetary gear, omitting a number of other types from consideration, and emphasizing the diesel-locomotive field in discussing electric drive. Also, a new chapter on the principles of hydrodynamics has been added.

WÄRMEÜBERGANG AN FLIESSENDES WASSER UNTER LOKALER OBERFLÄCHENVERDAMPFUNG—DER KÜHLSEITIGE WÄRMEÜBERGANG IN EINEM ZWEITAKT-DIESELMOTOR; EINFLUSS DER VERDAMPFUNG. By N. Dimopoulos. (Inst. f. Thermodynamik u. Verbrennungsmotoren, E. T. H. Zürich, no. 18.) Verlag Leeman, Zürich, Switzerland, 1955. 107 p., 6 5/8 × 9 3/8 in., paper. 12.50 Sw. fr. This two-part dissertation deals with the following topics: heat transfer to flowing water with local surface boiling—a review of the literature and a description of laboratory tests with discussion of results; heat transfer to the cooling side of a two-cycle diesel engine, effect of boiling—description and results of tests on a 900-hp diesel engine.

WORLD COMMERCE AND GOVERNMENTS. Trends and Outlook. By W. S. Woytinsky and E. S. Woytinsky. Twentieth Century Fund, New York, N. Y., 1955. 907 p., 10 1/4 × 7 1/4 in., bound. $10. This large volume, a compendium of information drawn from many sources, contains a vast amount of explanatory and statistical material on world trade in mineral fuels, ores and metals, manufactured articles, raw materials, and other components of world commerce. About a quarter of the contents is devoted to the discussion of land, water, and air transportation, with information given on numbers and types of locomotives, motor vehicles, merchant vessels, aircraft, etc. The volume as a whole outlines current changes in commerce, transportation, and the political and financial organization of nations. Along with its companion volume "World Population and Production" (1953), it provides a broad picture of economic forces and trends in the mechanized economy of the modern world.

1954 JAHRBUCH DER WISSENSCHAFTLICHEN GESELLSCHAFT FÜR LUFTFAHRT. Edited by Hermann Blenk. Friedr. Vieweg & Sohn, Braunschweig, Germany, 1955. 324 p., 11 3/4 × 8 1/4 in., bound. 36 DM. This volume of the Yearbook of the German Aeronautical Society contains 19 papers on various technical aspects of aerodynamics, propulsion, aircraft structures, and air transport, and 13 papers on aviation medicine and biology. Five of the papers are in English; the remainder are in German with English and French summaries. This same organization also publishes a monthly magazine, *Zeitschrift für Flugwissenschaften*.

ASME Boiler and Pressure Vessel Code

Interpretations

THE Boiler and Pressure Vessel Committee meets monthly to consider "Cases" where users have found difficulty in interpreting the Code. These pass through the following procedure: (1) Inquiries are submitted by letter to the Secretary of the Boiler and Pressure Vessel Committee, ASME, 29 West 39th Street, New York 18, N. Y.; (2) Copies are distributed to Committee members for study; (3) At the next Committee meeting interpretations are formulated to be submitted to the ASME Board on Codes and Standards, authorized by the Council of the Society to pass upon them; (4) They are submitted to the Board for action; (5) Those which are approved are sent to the inquirers and are published in MECHANICAL ENGINEERING.

(The following Case Interpretations were formulated at the Committee meeting January 13, 1956, and approved by the Board on March 6, 1956.

Correction to Case No. 1204-1 (Reopened)

In the Reply, second line of Par. (6), the head thickness should be "0.58 in." instead of "0.50 in."

Case No. 1213

(Interpretation of Specification SA-182)

Inquiry: May the hydrostatic test specified for forged alloy steel fittings manufactured to Specification SA-182 be waived for those fittings to be used in Code construction?

Reply: Because it is frequently impractical to perform hydrostatic tests on each fitting at the plant of the fittings manufacturer, it is the opinion of the

Committee it will meet the intent of the Code to waive the test at this stage of manufacture provided the subassembly or assembly, of which the fitting is a component part, is subjected to a hydrostatic test prescribed by the Code prior to operation.

Case No. 1216

(Special Ruling)

Inquiry: Specification SA-278 requires that the test bar be cooled at the same rate as the casting. Because of the large mass involved in large castings of dryer rolls which weigh in excess of 25 tons, the test bars cooled at this rate are not representative of the dryer roll. Is it permissible to take the test bars in accordance with Specification SA-48 which have been found to correlate with these large castings?

Reply: It is the opinion of the Committee that it is permissible to take the test bars in accordance with Specification SA-48 pending further study of the rules of Specification SA-278 for test bars representative of large castings slowly cooled as described in the Inquiry.

Annulment of Cases

The following Cases are to be annulled:

CASE NOS.	REASON FOR ANNULMENT
970, 1098-1, 1147-1, 1157, 1167	Provisions are now included in Section VIII.
1130	Lack of use.
1185	Substance of Case included in Table UNF-23.

Proposed Revisions and Addenda to Boiler and Pressure Vessel Code . . .

As NEED arises, the Boiler and Pressure Vessel Committee entertains suggestions for revising its Codes. Revisions approved by the Committee are published here as proposed addenda to the Code to invite criticism. If and as finally approved by the ASME Board on Codes and Standards, and formally adopted by the Council, they are printed in the annual addenda supplements to the Code. Triennially the addenda are incorporated into a new edition of the Code.

In the following the paragraph numbers indicate where the proposed revisions would apply in the various sections of the Code.

Comments should be addressed to the Secretary of the Boiler and Pressure Vessel Committee, ASME, 29 West 39th Street, New York 18, N. Y.

Power Boilers, 1952

PAR. P-25(1) of the 1955 Addenda Revise the last sentence to read: "For pressures over 100 psi, the thickness shall be not less than listed for schedule 80 pipe."

TABLE P-7 Under Pipe & Tubes, Seamless Carbon Steel, add new Grade C to SA-106 as follows:

Spec. Min. Tensile	For metal temperatures not exceeding deg F —20 to 650	700	750	800
70,000	17,500	16,600	14,750	12,000

Add the accompanying stress values.

ADDITIONAL MATERIALS AND STRESS VALUES TO BE ADDED TO TABLE P-7

Spec. No.	Grade	Nom. Comp.	Spec. Min. Tensile	Notes	For metal temperatures not exceeding deg F —20 to 100	200	300	400	—20 to 400	500	600	650	700
PLATE STEELS													
Low-Alloy Steel													
SA-387	A	1/2 Cr-1/2 Mo	65000	...	...	...	...	...	16250	16250	16250	16250	16250
SA-387	B	1 Cr-1/2 Mo	60000	...	...	...	...	...	15000	15000	15000	15000	15000
SA-387	C	1 1/4 Cr-1/2 Mo-Si	60000	...	...	...	...	...	15000	15000	15000	15000	15000
SA-387	D	2 1/4 Cr-1 Mo	60000	...	...	...	...	...	15000	15000	15000	15000	15000
SA-387	E	3 Cr-1 Mo	60000	...	...	...	...	...	15000	15000	15000	15000	14800
FORGINGS													
Alloy Steel													
SA-182	F5a	5 Cr-1/2 Mo	60000	...	...	...	...	...	15000	14500	14000	13700	13400
SA-336	F5a	5 Cr-1/2 Mo	60000	...	...	...	...	...	15000	14500	14000	13700	13400
SA-336	F22	2 1/4 Cr-1 Mo	70000	...	...	...	...	...	17500	17500	17500	17500	17500

For metal temperatures not exceeding deg F 750	800	850	900	950	1000	1050	1100	1150	1200	Spec. No.	Grade
										PLATE STEELS	
										Low-Alloy Steel	
16250	15650	14400	*12500*	*8500*	*5500*	..	..	..	..	SA-387	A
15000	14750	14200	13100	11000	7500	5000	2800	*1550*	*1000*	SA-387	B
15000	15000	14400	13100	11000	7800	5500	4000	*2500*	*1200*	SA-387	C
15000	15000	14400	13100	11000	7800	5800	4200	3000	2000	SA-387	D
14500	13900	13200	12000	9000	7000	5500	4000	2700	1500	SA-387	E
										FORGINGS	
										Alloy Steel	
13100	12800	12400	11500	10000	7300	5200	3300	2200	1500	SA-182	F5
13100	12800	12400	11500	10000	7300	5200	3300	2200	1500	SA-336	F5
17500	17500	16000	14000	11000	7800	5800	4200	3000	2000	SA-336	F22

Material Specifications, 1952

The Boiler and Pressure Vessel Committee has approved the following revisions and additions to Section II:

NONFERROUS MATERIALS

SB-178-55T—Delete Grade GM40A

SB-211-55T—Delete Grades 990A, CM-41A, CB60A, GR20A and ZG62A

SB-234-55T—Approved only for Grades GS11A, M1A and Clad M1A Core and Coating

SB-247-55T—Approved only for Grades CS41A, GS11A, GS11B and M1A

SB-273-55T—(1) Delete the statement "Table 1. For alloy CS41A revise the figure under column headed 'Chromium per cent' from '0.25' to read '0.10.'" (2) Approved only for Grades CG42A and GS11A

SB-274-55T—Approved only for Grades GS10A, GS11A, M1A and Clad M1A Core and Coating

Unfired Pressure Vessels, 1952

PAR. UW-33 Add "nominal" before "plate thickness" in the fifth line. Delete the words ". . . except that for plates less than $^1/_4$ inch in thickness the offset may be as much as $^1/_{16}$ inch" in the sixth line.

PAR. UW-34 Revise the tabulation to read as follows:

For plates up to and including $^3/_4$ in. in thickness—25 per cent of the nominal plate thickness.

For plates over $^3/_4$ in. and up to and including $1^1/_2$ in. in thickness—$^3/_{16}$ in.

For plates over $1^1/_2$ in. in thickness—$12^1/_2$ per cent of the nominal plate thickness but not to exceed $^1/_4$ in.

TABLE UCS-23 Add the accompanying stress values. Under Pipe & Tubes, Seamless Carbon Steel, add new Grade C to SA-106 as follows:

Spec. Min. Tensile	For metal temperatures not exceeding deg F —20 to 650	700	750	800
70,000	17,500	16,600	14,750	12,000

TABLE UCS-27 Add the following stress values.

For Metal Temp. Not Exceeding Deg F	SA-214 Low-Carbon Steel Weld: Resis. Notes (2) & (3) Spec. Min. Tensile
—20 to 650	10,000
700	9700
750	8950
800	7800
850	6650
900	5500
950	3800
1000	2100

PAR. UCI-101(a) Revise to read:

UCI-101 *Hydrostatic Test to Destruction* (*a*) The maximum allowable working pressure of identical cast iron vessels, based on testing one of them to destruction in accordance with Par. UG-101(m) shall be:

$$P_R = \frac{P_B}{6.67} \times \frac{\text{(Specified Minimum Tensile Strength)}}{\left(\begin{array}{c}\text{Minimum Tensile Strength of}\\ \text{Associated Arbitration Bar}\end{array}\right)}$$

where P_R = maximum allowable working pressure at operating temperatures listed in Table UCI-23 in pounds per square in.

P_B = destruction test pressure in pounds per square in.

The principle of Par. UG-101(c) shall be followed.

Note: It is assumed that failure will occur in bending.

Announcement

The Boiler and Pressure Vessel Committee is considering annulling Case Nos. 905-2 (Reopened) (Special Ruling) and 941-3 (Reopened) (Special Ruling). Comments are welcome.

ADDITIONAL MATERIALS AND STRESS VALUES TO BE ADDED TO TABLE UCS-23

Mat'l & Spec. No.	Grade	Nom. Comp.	Spec. Min. Tensile	Notes	For Metal Temperatures Not Exceeding Deg F —20 to 650	700	750	800	850	900	950	1000	1050	1100	1150	1200
Plate Steels																
Low-Alloy Steels																
SA-387	A	$^1/_2$ Cr-$^1/_2$ Mo	65000	...	16250	16250	16250	15650	14400	12500	10000	6250	..	..	..	..
SA-387	B	1 Cr-$^1/_2$ Mo	60000	...	15000	15000	15000	14750	14200	13100	11000	7500	5000	2800	1550	1000
SA-387	C	$1^1/_4$ Cr-$^1/_2$ Mo-Si	60000	...	15000	15000	15000	15000	14400	13100	11000	7800	5500	4000	2500	1200
SA-387	D	$2^1/_4$ Cr-1 Mo	60000	...	15000	15000	15000	15000	14400	13100	11000	7800	5800	4200	3000	2000
SA-387	E	3 Cr-1 Mo	60000	...	15000	14800	14500	13900	13200	12000	9000	7000	5500	4000	2700	1500
Pipes & Tubes																
Seamless Carbon Steels																
SA-179	..	...	...	(4)(6)	11750	11450	10550	9200	7850	6500	...	..	..	..	..	..
Seamless Low-Alloy Steels																
SA-199	T3b	2 Cr-$^1/_2$ Mo	60000	...	15000	15000	15000	14700	14000	12500	10000	6200	4200	2750	1750	1200
SA-199	T5	5 Cr-$^1/_2$ Mo	60000	(14)	...	13400	13100	12800	12400	11500	10000	7300	5200	3300	2200	1500
SA-199	T7	7 Cr-$^1/_2$ Mo	60000	(14)	...	13400	13100	12500	11500	9500	7000	5000	3500	2500	1800	1200
SA-199	T9	9 Cr-1 Mo	60000	(14)	...	13400	13100	12800	12500	12000	10800	8500	5500	3300	2200	1500
SA-199	T11	$1^1/_4$ Cr-$^1/_2$ Mo	60000	...	15000	15000	15000	15000	14400	13100	11000	7800	5500	4000	2500	1200
SA-199	T21	3 Cr-0.9 Mo	60000	...	15000	14800	14500	13900	13200	12000	9000	7000	5500	4000	2700	1500
SA-199	T22	$2^1/_4$ Cr-1 Mo	60000	...	15000	15000	15000	15000	14400	13100	11000	7800	5800	4200	3000	2000
Forgings																
Low-Alloy Steels																
SA-182	F5	5 Cr-$^1/_2$ Mo	60000	(14)	...	13400	13100	12800	12400	11500	10000	7300	5200	3300	2200	1500
SA-182	F7	7 Cr-$^1/_2$ Mo	60000	(14)	...	13400	13100	12500	11500	9500	7000	5000	3500	2500	1800	1200
SA-336	F5	5 Cr-$^1/_2$ Mo	60000	(14)	...	13400	13100	12800	12400	11500	10000	7300	5200	3300	2200	1500
SA-336	F22	$2^1/_4$ Cr-1 Mo	70000	...	17500	17500	17500	17500	16000	14000	11000	7800	5800	4200	3000	2000

Add to Note (14):

Spec.	Grade	For Metal Temperatures Not Exceeding Deg F —20 to 400	500	600	650
SA-199	T5	15000	14500	14000	13700
SA-199	T7	15000	14500	14000	13700
SA-199	T9	15000	14500	14000	13700

Spec.	Grade	For Metal Temperatures Not Exceeding Deg F —20 to 400	500	600	650
SA-182	F5	15000	14500	14000	13700
SA-182	F7	15000	14500	14000	13700
SA-336	F5	15000	14500	14000	13700

ASME News

With Notes on the Engineering Profession

E. S. Newman, *News Editor*

President Barker Chosen Dinner Speaker at SAM-ASME Management Engineering Conference, New York, April 26-27

SPARKLING with know-how speakers drawn from throughout the United States, a trend-setting program has been planned for the eleventh annual Management Engineering Conference, sponsored jointly by the Society for Advancement of Management and the Management Division of The American Society of Mechanical Engineers, to be held on Thursday and Friday, April 26-27, at the Hotel Statler, New York, N. Y.

Joseph W. Barker, President of ASME, will be the principal speaker at the dinner on Thursday evening. Dr. Barker will deliver an address on one of the most important problems of our time, "The Role of Management in Meeting Technological Manpower Requirements." He will be introduced by Frank F. Bradshaw, SAM president. Dr. Bradshaw will also present SAM Annual Awards, including The Gilbreth Medal, Human Relations Award, Industrial Incentives Award, Material Handling Award, and the Taylor Key.

In meeting the bold challenges now rising in every phase of management engineering, the entire United States was surveyed to bring to the Conference those able speakers who are setting the trends for tomorrow in the latest-proved techniques of business and industry, in accord with the conference theme, "Management Know-How—U. S. A." The conference program features new techniques of practical interest to management executives and engineers, selected by the acid test of demonstrated accomplishment.

There will be 16 distinguished technical speakers among eight functional sessions dealing with: Operations Research—What are we seeking? Information Processing—How will we record it? Automation—How will we make it? Work Measurement—How will we measure it? Statistical Techniques—How will we check it? Material Handling—How will we transport it? Maintenance Control—How will we maintain it? And Cost Reduction—How will we improve it?

Inspirational speakers will feature the two luncheon sessions. On Thursday Dr. Gaylord P. Harnwell, President of the University of Pennsylvania, will speak on, "The Role of Education in Developing Management Know-How." On Friday Joseph L. Kopf, treasurer, ASME, and president of Jabez Burns and Sons, New York, N. Y., will chart future progress in "Management—Where Are We Going?"

Some 2000 management executives and engineers from all types of companies and industries are expected to gather at this annual conference of the two national societies.

The Poor Richard Club's Almanack Medal and Certificate "For Distinguished Service in the 250th Anniversary of the Birth of Benjamin Franklin" has been awarded to ASME. The Club created this Medal on its own Golden Anniversary. It is awarded to those who, in the tradition of Benjamin Franklin, have done distinguished work in the world-wide communication of ideas in memory of the Club's Patron Saint. The award was given to ASME for its constructive leadership in suggesting co-operation by Sections of ASME which resulted in excellent programs in many sections of the country, contributing materially to the success of the Benjamin Franklin Anniversary Program.

International Conference on Fatigue of Metals, London, September, 1956

THE Institution of Mechanical Engineers, London, England, is organizing an International Conference on Fatigue of Metals to be held at the Institution from Monday, September 10, to Friday, September 14, 1956.

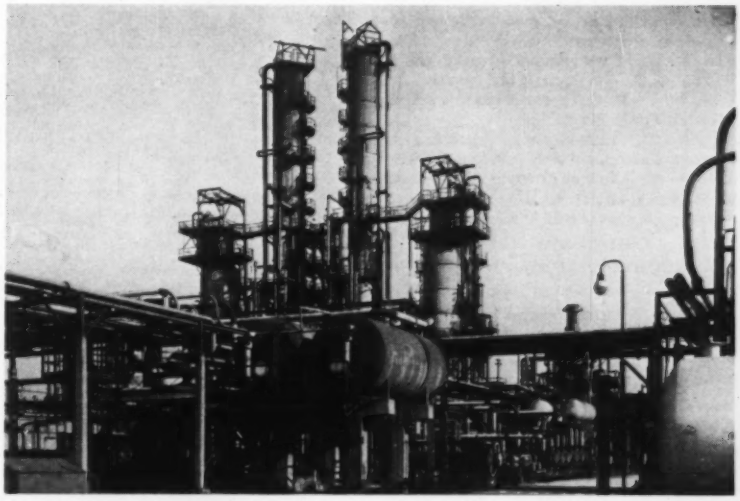
The papers already approved by a Committee of the Institution will be presented in London in September and, by co-operation with the Applied Mechanics Division of The American Society of Mechanical Engineers, these will again be presented during a series of meetings to be held during the ASME Annual Meeting, New York, N. Y., Nov. 25–30, 1956.

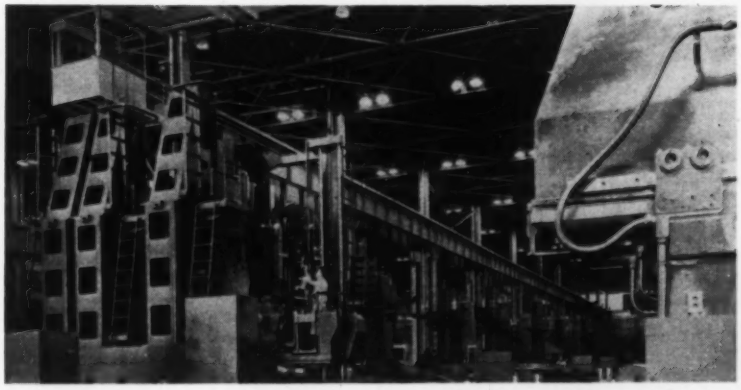
The sessions will cover the following subjects: stress effects, effect of temperature and environment, metallurgical aspects, basic studies, engineering and industrial significance of fatigue.

Further particulars and copies of the papers, when available, may be had by addressing the Secretary, The American Society of Mechanical Engineers, 29 W. 39th Street, New York 18, N. Y., U. S. A., or the Secretary, The Institution of Mechanical Engineers, 1 Birdcage Walk, London, S. W. 1, England.

Inspection Trips—A Feature of ASME Semi-Annual Meeting, Cleveland, Ohio, June 17–21, 1956

Standard Oil Company (Ohio). At the Standard Oil Company's No. 1 Refinery, Cleveland, visitors will see how crude oil, the basic raw material, is separated into various higher and lower boiling parts which are then subjected to different types of treatment to manufacture the desired products. This refinery, with a continuous history of operation extending back to 1870, has kept pace with the advances and development in the industry. Process units and mechanical shops will be seen. Headquarters for the ASME Semi-Annual Meeting will be in the Hotel Statler.





USAF Heavy-Press Plant. This battery of tracer-controlled die-sinking machines cut the forging cavities in steel die blocks weighing many tons. The big die shop, located in the USAF Heavy-Press Plant operated by the Aluminum Company of America in Cleveland, Ohio, will be visited June 19.

Ford Motor Company. Mechanical arms of steel move Ford and Mercury engines throughout Ford's Engine Plant No. 1 in Cleveland without manual handling. The unique arms position the engines at every desired angle for assemblers. The conveyer system—the first used in the automotive industry at the Cleveland plant—enables workmen to avoid fatigue, and thus they are able to concentrate fully on precision in assembly and quality control of product.

Nuclear Power Plants—Topic of ASME Pittsburgh Section Conference

THE Pittsburgh Section of The American Society of Mechanical Engineers has completed plans for their tenth annual Mechanical-Engineering Conference and President's Banquet to be held at the Hotel William Penn in Pittsburgh, Pa., on April 30 and May 1.

The subject for this two-day meeting will be "Nuclear Power Plants."

Conference Chairman, M. J. Warneke, and Program Chairman, R. M. Buchanan, have arranged the following program which should be of unusual interest to all mechanical engineers working in the field of power generation:

MONDAY, APRIL 30, 1956

8:00 a.m.

Registration

9:00 a.m.

Technical Sessions

A Survey of Power-Reactor Types, by *W. E. Shoupp,* Westinghouse Commercial Atomic Power Department

Reactor Safeguards, by *Charles D. Luke,* assistant director, Civilian Application for Reactor Hazards, U. S. Atomic Energy Commission

Personnel Programs at Shippingport Nuclear Power Plant, by *L. R. Lowe,* chief engineer, Shippingport Station, Duquesne Light Company

12:15 p.m.

Luncheon

Speaker: *A. C. Pasini,* Vice-President, ASME Region V

Subject: **A Few Accomplishments of Our Profession**

2:00 p.m.

Technical Sessions

Valve Specialties for Nuclear Power Plants, by *John Thorel,* Westinghouse Nuclear Equipment Department

Zero Leakage Pumping, by *W. N. Wepfer,* Westinghouse Atomic Equipment Department

Instruments as Applied to Nuclear Power Plants, by *Martin Kendziorek,* Westinghouse Atomic Equipment Department

Remote Maintenance Problems, by *C. A. Strowe,* district engineer, Blaw-Knox Co.

6:00 p.m.

Social Hour

7:00 p.m.

Banquet

Toastmaster: *R. J. S. Pigott,* Past-President ASME

Speaker: *Joseph W. Barker,* ASME President

Subject: **Atomic Energy**

Informal, Women invited

TUESDAY, MAY 1, 1956

8:00 a.m.

Registration

9:00 a.m.

Technical Sessions

Chemistry of the Primary System, Panel Discussion, *S. F. Whirl,* Duquesne Light Co.; *Paul Cohen,* Westinghouse Electric Corp.; (Third member to be announced)

Shippingport Start-Up Procedure, by *G. M. Oldham,* superintendent, Shippingport Station, Duquesne Light Co.

Recovery of Spent Fuel, by *H. B. Coats,* manager, Atomic Energy Department, Blaw-Knox Co.

12:15 p.m.

Inspection Trip

Shippingport Power Station of the Duquesne Light Co. This is America's first full-scale atomic-energy electric power plant, which is well under construction. When completed the nuclear reactor will produce at least 60,000 kw of net electrical output, and the plant's turbine-generator will have a maximum capability of 100,000 kw.

Duquesne Light Co. is building the Shippingport plant in co-operation with the U. S. Atomic Energy Commission. Westinghouse Electric Corp. under contract with the AEC is building the reactor, while Duquesne Light Co. is constructing the turbine-generator portion of the plant, and will operate the entire plant when it is completed in 1957.

Transportation to and from Shippingport will be by special bus only. Buses will leave the Hotel William Penn and luncheon will be provided en route.

A scale model of the Shippingport Power Station has been loaned by the U. S. Atomic Energy Commission for display at the conference.

Tickets for the Monday Luncheon and Banquet and for the Shippingport trip will be on sale at the registration desk on Monday morning, April 30. There will be no advanced registration or ticket sale before the meeting. Room reservations should be arranged directly with the hotel.

Plans for the ASME Pittsburgh Section Spring Conference on Nuclear Power Plants are discussed by: ***left to right,*** **R. M. Buchanan, Program Chairman; H. R. Fulton, Publicity Chairman; E. S. Howarth, Entertainment Chairman; W. Forstall, Registration Chairman; J. R. Aikins, Chairman, Pittsburgh Section; and M. J. Warneke, General Conference Chairman**

ASME Coming Events

April 10–11
ASME Machine Design Division Conference, Bancroft Hotel, Worcester, Mass.
(Final date for submitting papers was Dec. 1, 1955)

April 16–17
ASME Gas Turbine Power Division Conference, Hotel Statler, Washington, D. C.
(Final date for submitting papers was Dec. 1, 1955)

April 26–27
Eleventh Annual ASME-SAM Management-Engineering Conference, Hotel Statler, New York, N. Y.

May 8–11
ASME Metals Engineering-AWS Conference, Hotel Statler, Buffalo, N. Y.
(Final date for submitting papers was Dec. 31, 1955)

May 23–25
ASME-EIC Meeting, Mount Royal Hotel, Montreal, Que., Can.
(Final date for submitting papers was Dec. 31, 1955)

June 11–13
ASME Applied Mechanics Western Division Conference, California Institute of Technology, Pasadena, Calif.
(Papers being accepted until program is filled)

June 14–16
ASME Applied Mechanics Division Conference, University of Illinois, Urbana, Ill.
(Final date for submitting papers was Feb. 1, 1956)

June 17–21
ASME Semi-Annual Meeting, Hotel Statler, Cleveland, Ohio
(Final date for submitting papers was Feb. 1, 1956)

June 19–22
ASME Boiler and Pressure Vessel Committee Out-of-Town Meeting held jointly with the National Board of Boiler and Pressure Vessel Inspectors, Windsor Hotel, Montreal, Que., Can.

Sept. 10–12
ASME Fall Meeting, Cosmopolitan Hotel, Denver, Colo.
(Final date for submitting papers—May 1, 1956)

Sept. 17–21
ASME Instruments and Regulators Division and Instrument Society of America Exhibit and Joint Conference, Coliseum, New York, N. Y.
(Final date for submitting papers—May 1, 1956)

Sept. 23–26
ASME Petroleum-Mechanical Engineering Conference, Conrad Hilton Hotel, Dallas, Texas
(Final date for submitting papers—May 1, 1956)

Oct. 8–10
ASME-ASLE Third Lubrication Conference, Chalfonte-Haddon Hall, Atlantic City, N. J.
(Final date for submitting papers—June 1, 1956)

Oct. 24–25
ASME-AIME Joint Fuels Conference, Sheraton Park Hotel, Washington, D. C.
(Final date for submitting papers—June 1, 1956)

Nov. 25–30
ASME Annual Meeting, Hotel Statler, New York, N. Y.
(Final date for submitting papers—July 1, 1956)
(For Meetings of Other Societies, see page 390)

View of Buffalo, N. Y., where ASME Metals Engineering Division will present four technical sessions at American Welding Society spring meeting, Hotel Statler, May 7–11, 1956

ASME Metals Engineering Division Announces Program for AWS Spring Meeting in Buffalo, N. Y.

A TOTAL of 63 technical papers will be presented at 21 sessions during the national spring meeting of the American Welding Society to be held at the Hotel Statler, Buffalo, N. Y., May 7 to 11. Four sessions will be sponsored by the Metals Engineering Division of The American Society of Mechanical Engineers. A session on nuclear-reactor components will be presented by the Welding Committee of the U. S. Atomic Energy Commission.

Welding Show

The fourth Welding Show, largest ever held, will be at the Memorial Auditorium, May 9 to 11, and the second Welding Conference also will be at the auditorium.

J. H. Humberstone, AWS president, will open the spring meeting and J. J. Chyle, first vice-president of AWS, will digest the technical meeting papers at the opening session. R. W. Clark, S. A. Greenberg, and C. E. Jackson will report on "European Welding Operations."

Tentative Program

TUESDAY, MAY 8, 1956
(Afternoon)

Welding of Dissimilar Metals

Development of a Ferritic-Austenitic Weld Joint for Steam-Plant Application and Simulated Service Tests, by *F. Eberle* and *J. T. Tucker*, The Babcock & Wilcox Co.

Butt-Welding Austenitic Stainless Steel to Ferritic Steel in Cylindrical Shapes, by *J. E. Donahue*, Westinghouse Electric Corp.

Carbon Migration in Welded Joints at Elevated Temperature and Its Effect on Certain Mechanical Properties, by *Robert J. Christoffel, Robert M. Curran,* and *John E. Corr*, General Electric Co.

WEDNESDAY, MAY 9, 1956
(Morning)

Type 347 Stainless Steel

Time and Temperature Dependence of Welded-Joint Properties, by *J. Heuschkel*, Westinghouse Research Laboratories

Time-Temperature Effect on Properties of Weld Heat-Affected Zone in Type 347 Stainless Steel, by *E. F. Nippes*, Rensselaer Polytechnic Institute, *W. L. Fleischmann* and *R. L. Mehan*, General Electric Co., and *B. Schaaf*, Westinghouse Electric Corp.

Some Considerations in the Welding of Austenitic Chromium-Nickel Stainless Steels, by *O. R. Carpenter* and *R. D. Wylie*, The Babcock & Wilcox Co.

Piping and Tubing

Arc Welding of 2¼ Per Cent Cr-1 Per Cent Mo Alloy-Steel Pipe, by *Jay Bland*, Standard Oil Co. of Ind.

Joining Tubes to Tube Sheets for Corrosive Radioactive Chemical Service, by *W. R. Smith*, General Electric Co.

Economics of Welding in Small, Noncritica Piping, by *Herschel A. Sosnin*, Tube Turns, Inc.

Brazing and Soldering

Fatigue Strength of Silver-Alloy Brazed Joints in Steel, by *Chester H. Chatfield*, Handy & Harman

Physical Properties of Commercial Silver-Copper-Phosphorus Alloys, by *Karl M. Weigert*, Curtiss-Wright Corp.

Principles and New Developments of Tin-Zinc Alloys for Soldering Aluminum, by *Arthur S. Laurenson*, Belmont Smelting & Refining Works, Inc.

WEDNESDAY, MAY 9, 1956
(Afternoon)

Tests of Welds

Correlation of Test Requirements With Characteristics of Welded Fabrication, by *Helmut Thielsch*, Grinnell Co.

Inspector's Interpretation of Results of Tests on Welds, by *T. R. Hardin*, Hartford Steam Boiler Inspection & Insurance Co.

High Alloys

Rupture Properties of Inconel Weldments at 1400, 1600, and 1800 F, by *Donald A. Scott*, International Nickel Co. of Canada, Ltd.

Nickel-Chromium-Iron Weldments—Through the Microscope, by *Henry J. Albert* and *Frank Sauersopf*, General Dynamics Corp.

Welding the Cupro-Nickels by the Inert-Gas-Shielded-Arc Processes, by *Lowell H. Hawthorne*, Revere Copper & Brass, Inc.

Welding and Cutting Processes

Ultrasonic Welding, by *J. Byron Jones*, Aeroprojects, Inc., and *James J. Powers, Jr.*, Pitman-Dunn Laboratories

Tungsten-Arc Cutting of Aluminum, by *R. L. O'Brien, G. W. Oyler,* and *J. Maier, 3rd*, Linde Air Products Co.

Comparison of Mechanical With Thermal Methods of Cutting Aluminum and Stainless Steel, by *Edward H. Roper*, Air Reduction Sales Co.

THURSDAY, MAY 10, 1956
(Morning)

Higher Working Stresses

Evaluation of the Significance of Charpy Tests for Quenched and Tempered Steels, by *P. P. Puzak* and *W. S. Pellini*, Naval Research Laboratory

The Significance of Fatigue Data in Pressure-Vessel Design, by *T. J. Dolan*, University of Illinois

The Significance of the Tensile Test in Pressure-Vessel Design, by *W. E. Cooper*, Knolls Atomic Laboratory, General Electric Co.

Balanced Pressure-Vessel Design and Construction for Improved Economics, by *C. R. Soderberg, Jr., J. J. Murphy,* and *D. B. Rossheim*, The M. W. Kellogg Co.

Stainless Steel

Calculation of Ferrite Content of Stainless-Steel Weld Metal, by *W. T. DeLong, G. A. Ostrom,* and *E. R. Szumachowski*, McKay Co.

Root Passes in Stainless Steel With New Inert-Arc Procedure, by *Eugene B. LaVelle, L. H. Rasmussen,* and *E. M. Kuchera*, General Electric Co.

Stress-Corrosion Cracking of Type 304 Austenitic Stainless Steel, by *Hugh L. Logan* and *Richard J. Sherman, Jr.*, National Bureau of Standards

Applications

Application of Pressure Welding to the Aircraft Industry, by *Arnold Lage*, Menasco Manufacturing Co

How to Reclaim Plant and Machinery by Practical Welding Applications, by *George G. Musted*, welding engineer

Nondestructive Testing of Welds, by *Warren J. McGonnagle*, Argonne National Laboratory

World Power Conference, June 17–23

THE Fifth World Power Conference will be held in Vienna, Austria, June 17 to 23. The theme selected for the Conference is "World Energy Resources in the Light of Recent Technical and Economic Developments."

The conference headquarters is at the Konzerthaus, Vienna III, Lothringerstrasse 20. The offices of the Conference will open on Friday, June 15, 1956, at 8:00 a.m.

The membership fee for participants is 1200 Austrian schillings. There are included in this price a set of the papers including the general reports and the *Conference Journal*. Members will be admitted to all the technical sessions and to the social events which make up the program.

Registration

Persons applying for membership of the Fifth World Power Conference must fill in a special form. It is requested that these forms, duly filled in, be submitted to the National Committee of the World Power Conference or representative of the participant's own country, together with the fee of 1200 Austrian schillings for each participant and 500 Austrian schillings for persons accompanying participants. The respective National Committees and World Power Conference representatives are requested to forward all applications and fees in bulk to the Austrian National Committee.

Social Events

Arrangements have been made for a number of interesting and important events during the week of the Conference. These include the opening meeting, a reception given by the Austrian Government for the foreign visitors, special gala performances at the state theaters, and a typical Viennese evening entertainment at the Schoenbrunn Palace.

Hydroelectric and Thermal Plants

There will also be a number of tours to the various hydroelectric plants, thermal plants, and industrial establishments in Austria, and to hydroelectric plants situated in the frontier areas of Germany, Italy, and Yugoslavia. The itinerary has been chosen to provide for visits to places of historical interest and to give participants the opportunity of seeing some of Austria's magnificent scenery. During the Conference week there will be whole-day and half-day excursions to the power plants located in Vienna and its neighborhood.

Whole-day and half-day trips through the immediate and more distant surroundings of Vienna, as well as conducted sight-seeing tours of the city and visits to other places of interest, have been arranged for the women.

Power Plants

Arrangements have been made for a number of tours to power plants and other interesting installations in Austria, which will take place after the conclusion of the Conference. These tours also include visits to places of historical and cultural interest and the routes will lead through some of the most beautiful parts of Austria. In order to emphasize the significance of the Central European Power Distribution System, some of the tours will include visits to power plants located in the frontier areas of Germany, Italy, and Yugoslavia.

Technical Papers

The papers submitted to the Fifth World Power Conference will not be read at the technical sessions. This is to keep all the available time free for discussions. The General Reporter will give only a short introduction to the topic for discussion.

Preprints of the papers submitted to the Conference and preprints of the general reports can be forwarded only to those participants whose applications reach the Austrian National Committee by April 15, 1956, at the very latest in the case of those participants living outside Europe, and April 30 in the case of those in European countries.

The papers and general reports will be published in full in the complete bound Transactions of the Fifth World Power Conference which will also contain summaries of the discussions, the Chronicle of the Conference, a list of participants, and an index.

Judging by the number of papers received by Nov. 15, 1955, it is thought possible that about 300 papers will be dealt with under five divisions.

For more detailed information on this conference write to the United States National Committee World Power Conference, 29 West 39th Street, New York 18, N. Y.

ASME Design Engineering Conference, in Philadelphia, to Hear Leaders in Field

Nine outstanding authorities in various aspects of design engineering will lead four days of discussion at the Design Engineering Conference to be held at Convention Hall, Philadelphia, Pa., May 14–17.

The conference, sponsored by the Machine Design Division of The American Society of Mechanical Engineers, will be held concurrently with, and at the same place as, the first Design Engineering Show, a new industrial exposition produced by Clapp & Poliak, Inc., New York, N. Y.

Conference Discussions

The series of discussions making up the conference are designed to point out the need for attracting men to the field, training them, and making provisions for rewarding them for any outstanding achievements, such as recognition for, and legal rights to, inventions. More technical topics to be discussed include cost reduction as an important element in design and selection of engineering materials, and the effect of the trend toward miniaturization.

Design Engineering Show

Exhibits at the Design Engineering Show will demonstrate components, materials, finishes, shapes, forms, and services used by design engineers for the manufacture of end products for consumer and industrial use. More than 150 companies have announced that they will have booths at the show with their engineers available to answer queries. It is anticipated that by show time the number of exhibitors will exceed 200.

Technical Program

The conference has been arranged by the ASME Machine Design Division, with editors from four leading magazines in the design-engineering field appointed as Papers Committee to draft the program. The editors include: Colin Carmichael, *Machine Design;* H. R. Clauser, *Materials & Methods;* George F. Nordenholt, *Product Engineering;* and Frank C. Oliver, *Electrical Manufacturing.*

Cost Reduction in Product Design

Monday, May 14. **Value Analysis in Product Design,** by *A. D. Bentley*, specialist, value analysis services section, General Electric Company, Schenectady, N. Y., and *W. L. Healy*, supervisor, data bureau, Philadelphia Works, General Electric Company, Philadelphia, Pa.

How to Get and Train Design Engineers

Tuesday, May 15. **How to Get and Train Design Engineers:** A panel discussion. *Chester Linsky*, professor, department of industrial engineering, Pennsylvania State University, University Park, Pa.; *A. A. Johnson*, manager of engineering, Switchgear Division, Westinghouse Electric Corporation, East Pittsburgh, Pa., and *Bernard J. Covner*, assistant vice-president, Dunlap & Associates, consultants, Stamford, Conn.

Materials and Miniaturization

Wednesday, May 16. **Selecting Engineering Materials for Products,** by *W. A. Irvine*, manager of production engineering, The Maytag Company, Newton, Iowa.

Problems in Miniaturization, by *William C. Schmidt*, systems-development engineer, Merrimack Valley Laboratory, Bell Telephone Laboratories, Inc., Lawrence, Mass.

Patents and Engineers

Thursday, May 17. **Recognition and Reward for Invention,** by *W. A. Steiger*, manager, patent department, Westinghouse Electric Corp., East Pittsburgh, Pa.

Rights of the Employees' Inventions, by *George V. Woodling*, patent attorney, Cleveland, Ohio.

Aerial view of Philadelphia, Pa., where ASME Machine Design Division will hold a Design Engineering Conference in conjunction with the first Design Engineering Show, at Convention Hall, May 14–17.

Shown is the Montreal harbor, one of the sights to be seen during the EIC-ASME Meeting to be held at the Mount Royal Hotel, Montreal, Que., Can., May 23–25, 1956

ASME to Participate in 70th Annual Meeting of The Engineering Institute of Canada, Montreal, May 23–25

As a result of the long-range policy of cooperation between The American Society of Mechanical Engineers and The Engineering Institute of Canada, ASME will participate in the 70th Annual General and Professional Meeting of The Engineering Institute of Canada to be held May 23–25, 1956, at the Sheraton-Mount Royal Hotel, Montreal, Que., Can.

EIC, an organization serving other fields of engineering as well as mechanical, programs at its annual meeting all types of engineering subjects. Their method of presentation differs slightly from that used at ASME meetings in that each paper is scheduled for a specific time as is shown in the tentative program below. ASME's participation in the program has been arranged by the following activities: Aviation, Management, Materials Handling, Power, and Production Engineering Divisions, and the Air-Pollution Controls and National Junior Committees. The Society's affiliate, The American Rocket Society, will also participate.

Some of the high lights of the meeting include luncheon addresses by R. E. Heartz, EIC President, and J. W. Barker, ASME President. On Thursday afternoon, May 24, Canadair, Ltd., has arranged for a visit to their facilities, as well as an air show. On Friday, May 25, D. F. Galloway, who will deliver the Calvin W. Rice Lecture at the ASME Semi-Annual Meeting in Cleveland, Ohio, in June, will speak on "Production Engineering Research in Britain." The meeting will be climaxed by the annual EIC banquet on Friday evening.

The tentative program follows:

WEDNESDAY, MAY 23, 1956

9:00 a.m. *FOYER*

Registration

10:00 a.m. *CHAMPLAIN ROOM*

Annual General Meeting

12:30 p.m. *SHERATON HALL*

Luncheon

Chairman: *E. D. Gray-Donald*, Chairman, Montreal Branch

Speaker: *Dr. R. E. Heartz*, President, The Engineering Institute of Canada

2:00 p.m. *BALLROOM*

Industrial Power Distribution, by *J. R. Auld*, Du Pont Company of Canada, Limited, Montreal

CHAMPLAIN ROOM

General Design of the St. Lawrence Seaway—Montreal Area, by *D. M. Ripley, Jr.*, St. Lawrence Seaway Authority, Montreal

BRITTANY ROOM

Application of Welded Design to Hydraulic Turbine and Valve Manufacture, by *J. G. Warnock*, English Electric Company, Limited, St. Catharines, Ont.

3:00 p.m. *BALLROOM*

The Growth and Development of Large Electric-Power Systems, by *W. R. Way*, Shawinigan Water and Power Company, Limited, Montreal

CHAMPLAIN ROOM

The Use of Hydraulic Models in the St. Lawrence Seaway Design, by *Duncan McIntyre*, St. Lawrence Seaway Authority, Montreal

BRITTANY ROOM

The Kaplan Turbine in Canada, by *G. D. Johnson*, S. Morgan Smith Company, York, Pa.

4:00 p.m. *BALLROOM*

Cross-Suspension System—Kemano Kitimat Transmission Line, by *H. B. White*, Aluminum Company of Canada, Limited, Montreal

CHAMPLAIN ROOM

The Mechanical-Design Features of the St. Lawrence Power Project, by *Otto Holden* and *P. Pemberton-Piggott*, Hydro Electric Power Commission of Ontario, Toronto

BRITTANY ROOM

Lateral Rigidity of Building Frames, by *J. L. de Stein*, McGill University, Montreal

6:00 p.m. *THE CHALET, MOUNT ROYAL*

Reception

6:30 p.m.

Welcome: His Worship, Mayor Drapeau

7:30 p.m. *THE CHALET, MOUNT ROYAL*

Supper

THURSDAY, MAY 24, 1956

9:00 a.m. *BALLROOM*

A Rapid and Accurate Method for Calculating the Transient Temperature in Composite Slab, by *W. F. Campbell*, National Research Council, Ottawa

CHAMPLAIN ROOM

Bersimis Power Development, by *F. P. Rousseau*, Quebec Hydro Electric Commission, Montreal

BRITTANY ROOM

Air-Pollution-Control Problems, by *E. A. Allcut*, University of Toronto, Toronto

SALON J

The Metal Bonding of Aircraft Assemblies, by *J. J. Waller*, Canadair, Limited, Montreal

10:00 a.m. *BALLROOM*

The Trans-Canada Radio-Relay Telephone System, by *A. J. Groleau*, Bell Telephone Company of Canada, Limited, Montreal

CHAMPLAIN ROOM

Survey of the Hamilton River, by *E. N. Webb*, British Newfoundland Corporation, Limited, Montreal

BRITTANY ROOM

Current Developments in Air Pollution in the United States, by *L. C. McCabe*, Resources Research Incorporated, Washington, D. C.

10:00 a.m. *SALON J*

The Challenge of Progress, by *R. C. Sebold*, Convair Division, General Dynamics Corporation, San Diego, Calif.

11:00 a.m. *BALLROOM*

Co-Operative Research in the British Electrical Industry, by *Jersy Miedzinski*, The Electrical Research Association, Greenford, England

CHAMPLAIN ROOM

Mechanical Design and Equipment of Labatt Brewery, Montreal, by *R. E. J. Layton*, T. Pringle & Sons, Limited, Montreal

BRITTANY ROOM

The Control of Air Pollution in England, by *S. B. G. Wilkinson*, Ministry of Housing and Local Government, London, England

Among those who participated in the 50th Anniversary Reunion Dinner of the ASME Meetings Committee held on February 17 at the Hotel Statler, New York, N. Y., was Arthur L. Williston *second from right in front row,* a member of the Society's first Meetings Committee. Shown with Mr. Williston, *left to right in first row,* are: F. M. Feiker, chairman of Committee in 1932; W. L. Batt, chairman in 1930, past-president and Hon. Mem. ASME; Joseph W. Barker, chairman in 1953 and ASME President; J. H. Davis, present chairman; Mr. Williston; and L. K. Sillcox, chairman in 1944, past-president and Hon. Mem., ASME; *second row:* R. F. Gagg, chairman in 1939; R. A. North, chairman in 1946; C. E. Davies, secretary, ASME; Roland W. Flynn, chairman in 1955; W. B. Wilkins and C. W. Parsons, members of Committee; *third row:* Glenn R. Fryling, member of Committee; T. A. Marshall, Jr., assistant secretary; Ernest Hartford, consultant; D. B. MacDougall, Meetings manager; O. B. Schier, 2nd, assistant secretary; and W. E. Reaser, member Publications Committee.

11:00 a.m. *SALON J*

American Rocket Society (to be announced)

2:00 p.m.

Canadair Visit and Air Show, Cartierville, P. Q.

8:00 p.m. *BRITTANY ROOM*

Joint ASME-Junior Section Meeting

Informal Reception

8:30 p.m.

E.I.C. Headquarters, 2050 Mansfield Street, Montreal

FRIDAY, MAY 25, 1956

9:00 a.m. *BALL ROOM*

Automation, Men, and Machines, by *J. J. Brown,* Consulting Engineer, Montreal

CHAMPLAIN ROOM

The Canadian Atomic-Power Program, by *I. N. MacKay,* Canadian General Electric Company, Limited, Peterborough, Ont.

BRITTANY ROOM

High-Speed Photography in Chemical Engineering, by *A. I. Johnson,* University of Toronto, Toronto

10:00 a.m. *BALLROOM*

Automating the Engineer's Task, by *Josef Kates,* K.C.S. Data Control, Limited, Toronto

CHAMPLAIN ROOM

Experimental Work on Coal-Burning Gas Turbines, by *D. L. Mordell,* McGill University, Montreal

BRITTANY ROOM

Modern Alloys for Industrial Use Above 1200 F, by *J. P. Ogilvie,* Shawinigan Chemicals, Limited, Montreal

11:00 a.m. *BALLROOM*

How the Mackinac Bridge Was Designed for Aerodynamic Stability, by *D. B. Steinman,* Consulting Engineer, New York, N. Y.

CHAMPLAIN ROOM

Boiler Development at Hearn Station, by The Babcock and Wilcox Co., New York, N. Y.

BRITTANY ROOM

Moving-Bed Processes, by *E. H. Lebeis,* Catalytic Construction Company, Philadelphia, Pa.

12:30 p.m. *SHERATON HALL*

ASME Luncheon

Chairman: *G. Ross Lord,* Chairman, Ontario Section ASME.

Speaker: *J. W. Barker,* President ASME

2:00 p.m. *BALLROOM*

Panel Discussion: **Long-Range Planning in an Atomic Age—Management**

Chairman: *L. F. Urwick,* Urwick Currie, Limited, Montreal

CHAMPLAIN ROOM

Panel Discussion: **Mass Transportation in Cities**

Chairman: *George S. Mooney,* St. Lawrence Municipal Bureau, Montreal

3:30 p.m.

Special Lecture

Production-Engineering Research in Britain, by *D. F. Galloway,* Research Association, Melton-Mowbray, England

Chairman: *J. W. Barker,* President, ASME

6:30 p.m. *CHAMPLAIN ROOM*

Reception

7:15 p.m. *BALLROOM*

The Annual Banquet

Chairman: *R. E. Hearts,* President, EIC

Speaker: *David L. Thomson,* Vice-Principal and Dean of the Faculty of Graduate Studies, McGill University, Montreal

Presentation of medals and prizes and introduction of the new president, V. A. McKillop, and new members of Council.

9:00 p.m. *CHAMPLAIN ROOM*

Annual Dance

(Dress optional)

9:00 p.m.

Reception

There will be an informal reception after the banquet when members and guests may meet the incoming and retiring presidents, distinguished guests, the chairman of the Montreal Branch, and their wives.

Meetings of Other Societies

April 10-11

Midwest Research Institute, industrial applications of analog computers, Hotel Phillips, Kansas City, Mo.

April 16-21

International Institution for Production Engineering Research, annual general assembly, Paris, France

April 17-21

Institute of Metal Finishing, annual conference, Blackpool, England

April 18-19

Armour Research Foundation, Illinois Institute of Technology, national industrial research conference, Sherman Hotel, Chicago, Ill.

April 26-27

American Institute of Electrical Engineers, conference on recording and controlling instruments. ASME and ISA are co-operating with AIEE. Bradford Hotel, Boston, Mass.

May 3-9

1956 Castings Congress and Show, Convention Hall, Atlantic City, N. J.

May 6-11

American Water Works Association, annual convention, St. Louis, Mo.

May 7-8

Metals Institute, second annual, Oklahoma A&M College, Stillwater, Okla.

May 7-9

Air-Conditioning and Refrigeration Institute, annual meeting, The Homestead, Hot Springs, Va.

May 9-11

Western Material Handling Conference and Equipment Show, Western Livestock Exhibit Building, Los Angeles, Calif.

May 11-12

Michigan Engineering Society, 76th annual convention, Pantlind Hotel, Grand Rapids, Mich.

May 11-15

Society of German Engineers, general assembly and celebration of the society's 100th Anniversary, Berlin, Germany

May 14-15

The Society of American Military Engineers, 36th annual meeting, Washington, D. C.

May 14-17

Design Engineering Show, Convention Hall, Philadelphia, Pa.

May 15-16

Armour Research Foundation, Illinois Institute of Technology, industrial nuclear technology conference, Museum of Science and Industry, Chicago, Ill.

May 16-18

Society for Experimental Stress Analysis, spring meeting, William Penn Hotel, Pittsburgh, Pa.

(*ASME Coming Events, see page 386*)

N. J. Hoff Receives Medal for European Lecture

Nicholas J. Hoff, Mem. ASME, and head of the department of aeronautical engineering and applied mechanics at the Polytechnic Institute of Brooklyn, Brooklyn, N. Y., has just returned from a lecture tour of Europe which was organized under the auspices of the Advisory Group for Aeronautical Research and Development (AGARD) of the North Atlantic Treaty Organization (NATO). Between January 11 and 27 he gave four lectures in the Scuola d'Ingegneria Aeronautica of the University of Rome, Italy, two at the Institut Henri Poincaré of the University of Paris, France, two at the Office National des Études et Recherches Aeronautiques (ONERA), the French equivalent of the NACA, at Chatillon s/S, a suburb of Paris, France, and one at the University of Liège, Belgium. The lectures were attended by over 200 representatives of the technical services of the air forces of these countries, of research and teaching personnel from many universities, scientific employees from governmental research organizations, and by representatives of almost every aeronautical industrial plant in these countries. The subject of the talks was the effect of high temperatures on the structural behavior of supersonic airplanes and missiles and included discussions of aerodynamic heating, heat transfer in the structure, thermal stresses, thermal buckling, creep, stress distribution in the presence of creep, and creep buckling.

N. J. Hoff

Dr. Hoff Honored

After the last lecture of the series, the University of Liège honored Dr. Hoff for the services he has rendered to the aeronautical sciences, to applied mechanics, and to international co-operation in aeronautics among the NATO nations, by bestowing upon him the medal of the University.

All the lectures were given in French.

William F. Durand compares model of swept-wing jet with the Wright Brothers Memorial Trophy, *left,* at his home in Brooklyn, N. Y., March 5, 1956, the day he celebrated his ninety-seventh birthday. Dr. Durand, past-president and Hon. Mem. ASME, who at the age of 80 came to be known as "dean of American engineering," received the trophy in 1948. He is the recipient of the most coveted honors and awards in the field of aeronautics. Famed first for an exhaustive series of tests on marine screw propellers, performed in the hydraulic laboratory at Cornell University under a grant from the Carnegie Institute, Dr. Durand turned, after his "retirement" in 1924, to air-propeller research. This he accomplished in the wind tunnel at Stanford University, where he catalogued the abilities of a hundred varying propeller models on the basis of their suitability for different sorts of tasks. In the Twenties he compiled his encyclopedic, six-volume Aerodynamic Theory, long the definitive work in its field. For it he obtained papers from 19 renowned aeronautical engineers. He was born in Beacon Falls, Conn., in 1859. He entered the United States Naval Academy at Annapolis, Md., in 1880, graduating to sea duty four years later as a junior engineer.

AGARD

The Advisory Group for Aeronautical Research and Development (AGARD) is an organ of the North Atlantic Treaty Organization (NATO) established for the purpose of intensifying research and development in aeronautics in the NATO nations and to facilitate the exchange of unclassified information. Its inception is due to Dr. Th. von Karman, Mem. ASME, who has been acting as chairman of the organization. Under him serves, as director, Dr. Frank L. Wattendorf, Mem. ASME. The Director of the International Exchange Program is Rolland A. Willaume. The AGARD offices are in Paris at the Palais de Chaillot.

The University of Liège, one of the two state universities in Belgium, was founded in 1817. It is particularly well known for its contributions to engineering education. The award to Dr. Hoff was made by Dr. A. Schlag, Dean of the School of Applied Sciences.

People

Honors and Awards. Joe Pintar, Mem. ASME, recently received the Department of Army Commendation for Meritorious Civilian Service, one of the highest honors conferred by the Army on a civilian. The presentation was made by Maj. Gen. G. C. Mudgett, Commanding General, Sixth Infantry Division, Fort Ord, Calif.

Harold B. Maynard, Mem. ASME, has been named 1956 recipient of the Wallace Clark Award "for his distinguished contribution to scientific management in the international field." Formal presentation will be made at a luncheon honoring him, April 11, 1956, at the Commodore Hotel, New York, N. Y. On February 6 Mr. Maynard received an honorary LLD degree from the University of Miami, at which occasion he addressed the graduating class on "Ten Years From Now."

Granger Davenport, Mem. ASME, chief

engineer, Gould & Eberhardt, Inc., Irvington, N. J., representing ASME on the American Standards Association Standards Council, was among the recipients of service scrolls in recognition of their work in the development of American Standards.

WALTER G. WHITMAN, head of the department of chemical engineering at the Massachusetts Institute of Technology, and Secretary General of the first United Nations Conference on the Peaceful Uses of Atomic Energy held in Geneva, Switzerland, in 1955, was the recipient of the 1956 Award and a speaker at the Engineers' Day held on January 20, at the Drexel Institute of Technology. Engineers' Day is an annual event conducted by the Drexel Federation of Student Engineering Societies.

The Institute of the Aeronautical Sciences presented four annual awards for outstanding contributions to aeronautics at the Honors Night Dinner, held January 23, at the Sheraton-Astor Hotel, New York, N. Y. The winners included: CAPT. WILBUR E. KELLUM, USN, commander of the Naval Medical Research Institute, Bethesda, Md., who received Jeffries Award for 1955; LIEUT. COL. ROBERT C. BUNDGAARD of the USAF Air Weather Service, Andrews AFB, Washington, D. C., Losey Award; J. JULIAN ALLEN of Ames Aeronautical Laboratory, National Advisory Committee for Aeronautics, Moffett Field, Calif., Reed Award; and GILES J. STRICKROTH, manager of the electronics department of The Glenn L. Martin Company, Baltimore, Md., Sperry Award. The late RALPH S. DAMON, Mem. ASME, who was president of Trans World Airlines at the time of his death Jan. 4, 1956, was named the American honorary fellow for 1955 by IAS. The posthumous award of the Institute's highest honor recognized Mr. Damon's lifetime career in aviation and his interest in the IAS. He served three terms on the IAS Council.

HAROLD L. HAZEN was elected a trustee of Robert College of Istanbul, Turkey. Dr. Hazen, among the outstanding engineering educators, is professor of electrical engineering and dean of the Graduate School at the Massachusetts Institute of Technology. He has cooperated in the design and construction of important electrical devices and been associated with Dr. Vannevar Bush in the development of the differential analyzer.

HENRY H. HAUSNER, a specialist in powder metallurgy and in the construction of atomic power plants, received the Stevens Institute of Technology Powder Metallurgy Achievement Award for 1956. Dr. Hausner is general manager of the Penn-Texas Corporation's Nuclear Engineering Division. The award, a 3-in. silver disk, was presented on February 20, at the Stevens Auditorium, Hoboken, N. J. Dr. Hausner delivered a paper at the ceremonies titled "Recent Advances in Powder Metallurgy in Both General and Nuclear Engineering Fields."

RICHARD Y. CASE, chief engineer, power-transmission department, United States Rubber Company, has been awarded the Edward Longstreth Medal of The Franklin Institute, Philadelphia, Pa., for inventing the timing belt, a rubber and fabric belt with teeth which is considered the most outstanding advance in power transmission during the past 50 years.

D. S. HARDER, an executive vice-president of Ford Motor Company, received an honorary DS degree in Industrial Engineering from Clarence B. Hilberry, president of Wayne University, at commencement exercises held January 31.

ROGER G. BATES of the National Bureau of Standards, Washington, D. C., internationally known authority in the field of electrochemistry, has won the Hillebrand Award of the American Chemical Society's Washington Section. Dr. Bates is a chemist in the Bureau's physical chemistry section.

New Officers. THOMAS H. CHILTON, Mem. ASME, has been elected president of Engineers Joint Council. He assumed office January 27. A former vice-president of EJC and former chairman of the Council's Manpower Commission, he is also a past-president of the American Institute of Chemical Engineers.

At the 62nd annual meeting of the American Society of Heating and Air-Conditioning Engineers, Cincinnati, Ohio, Jan. 23–25, 1956, the following newly elected officers were installed: JOHN W. JAMES, Mem. ASME, Chicago, Ill., president; PETER B. GORDON, Mem. ASME, New York, N. Y., first vice-president; ELMER R. QUEER, University Park, Pa., second vice-president; and RALPH A. SHERMAN, Fellow ASME, treasurer.

RALPH M. WESTCOTT, Mem. ASME, was elected president of the Consulting Engineers Association of California at their annual convention held in Fresno, Calif., Jan. 21–23, 1956. He is the first mechanical engineer to be so honored.

MAJ. GEN. JAMES B. NEWMAN, U. S. Air Force, Ret., has been nominated for president of The Society of American Military Engineers, and REAR ADM. H. ARNOLD KARO, Director, U. S. Coast and Geodetic Survey, for first vice-president of the society.

GEORGE A. DELANEY, chief engineer, Pontiac Motor Division, General Motors Corporation, Pontiac, Mich., took office as 1956 president of the Society of Automotive Engineers on January 13.

MERVIN S. COOVER, head of the electrical-engineering department, Iowa State College, Ames, Iowa, has been nominated for the 1956–1957 presidency of the American Institute of Electrical Engineers.

CARLTON S. PROCTOR of New York, N. Y., was elected president of the American Institute of Consulting Engineers. Col. Proctor, a former president of the American Society of Civil Engineers and a Trustee of Princeton University, is a partner in Moran, Proctor, Mueser & Rutledge.

MORREHEAD PATTERSON, Mem. ASME, chairman of the board and president of the American

Ralph M. Ferry, *center,* receives ASME Fellow pin and certificate from J. B. Jones, *right,* Vice-President, ASME Region IV, at Oak Ridge, Tenn., meeting. W. R. Gall, *left,* chairman of the East Tennessee Section, looks on. On this occasion other members of the Society were honored. Certificates were presented to: R. W. Holland for his work as chairman of the Eastern North Carolina Section; J. F. Bailey, chairman of the East Tennessee Section, 1955; and R. C. Robertson, secretary, National Nominating Committee, 1954 and 1955.

Machine and Foundry Company, New York, N. Y., has been appointed chairman of the Planning Committee on Standardization in the field of nuclear energy by the American Standards Association.

Campus News. DAVID W. R. MORGAN, past-president and Fellow, ASME, and retired vice-president of the Westinghouse Electric Corporation, has been appointed professor of engineering at Drexel Institute of Technology.

SIR RICHARD SOUTHWELL will be a visiting professor in mechanical engineering for the 1956–1957 academic year in the department of mechanical engineering, The Rice Institute, Houston, Texas. Sir Richard is a world-recognized authority in the fields of theory of elasticity and relaxation methods, and is the author of numerous papers and treatises on these subjects. During the 1956–1957 school year Sir Richard will teach a two-semester course entitled: "Theory of Elasticity and Relaxation Methods." He will also be available for consultation with graduate students working on research problems in these fields.

Seminar. GRAHAM PARKER, Mem. ASME, New York, N. Y., industrial consultant to numerous European and American corporations, conducted a two-day seminar on sales management and organization before the Commission Generale d'Organisation Scientifique (CEGOS) on February 20 and 21, in Paris, France.

ASME Chicago Section Holds First Annual "New Member" Dinner

THE first annual "New Member" dinner and meeting for the Chicago Section of The American Society of Mechanical Engineers was held Wednesday evening, Jan. 18, 1956, for the members who had joined the Chicago Section during the year 1955. Because the purpose of the meeting was to acquaint the new members with the ASME, the board members, and each other, no business was conducted.

During the social hour preceding the dinner the board members acted as hosts. They circulated among the new members, introduced themselves, and engaged the new members in conversation so that by the time dinner was served all had a feeling of "belonging" and identification with ASME.

The dinner was climaxed by an enlightening talk on the "Effects of the Atomic Explosions on the Weather," by Charles B. Johnson of the United States Weather Bureau. Mr. Johnson's discussion centered on the history of explosions and the public reaction to them. He explained how many thought Napoleon's extensive use of artillery was the cause of inclement weather. Mr. Johnson said this feeling has arisen during each major conflict. World War I was blamed for certain weather conditions. Now many people think atomic explosions disturb weather, but Mr. Johnson pointed out that the energy contained in one mild thunderstorm is more than 2000 times as great as in an atomic explosion. He concluded his remarks by expressing his belief that accurate control of the weather is a long, long way in the future.

Each of the 14 tables (representative of the 23 professional divisions of the Society) was hosted by two board members who led the discussion at their tables on the benefits and responsibilities of membership in the ASME. Each round-table discussion was recorded by a "secretary" who was one of the new members at the table. After the discussions at the tables had run for several minutes each secretary reported the consensus at his table.

A recording secretary was appointed who listed the comments and questions on two blackboards provided for the purpose. The spirit of the ASME was caught in the ensuing general discussion and the following points were brought out:

The members benefited as follows:

1 By enjoying good fellowship.
2 By association with fellow engineers.
3 By sharing knowledge and developing a satisfaction from mutual assistance.
4 By developing professionally and in social activities.
5 By meeting new people, procuring new ideas, and perhaps a new job.
6 By having a place to get information on what other men are doing.
7 By making business contacts at Society functions.
8 By the development of a professional division.
9 By informal-type meetings.
10 By keeping informed through the local and national meetings and magazines.

The members could help the organization by:

1 Participation in Society affairs, within time limits.
2 Liaison between societies.

There were only two unanswered questions raised orally during the discussion period, which were:

1 How can Student Branches make use of present liaison with the Section for vocational guidance?
2 What are the benefits of working on Society committees?

These questions were answered by Alex Bailey, past-president and Hon. Mem. ASME, who gave a heartwarming summary of the meeting. Mr. Bailey replied as follows:
"By serving the ASME as a committee member, you gain recognition of your ability by other members of the Section. You gain prestige through recognition by other Society members, you become interested in being helpful, thereby enhancing your value to the ASME, to society, and to your profession.

He also urged the young married members to encourage their wives to join the Woman's Auxiliary. He pointed out that one can go further and take a greater part in the Society's activities if he has the understanding and backing of his wife.

Mr. Bailey's closing advice to new members and old alike was—"to make yourself acquainted, go to the meetings, take part in the discussions and activities, and remember to make the ASME a better Society 'For it *is your* Professional Society'."

After the meeting was adjourned the scratch paper was collected from the various tables and a wealth of information was found which was not brought up at the meeting but which should be brought up at future meetings. Some of the comments were as follows:

1 Is ASME a sufficient organization for ourselves as engineers or do we need a union?
2 Can we be professionals in the true sense and still work for others (unlike doctors and lawyers)?
3 ASME activities are a change of pace from daily routine—give one an opportunity to meet with outstanding individuals for sociable motives, feeling of belonging, and finding acceptance with people of similar interest.
4 We enjoy this small informal type of meeting.
5 We enjoy participation in activities other than mere attendance at meetings.
6 As a technical salesman, I think the most important benefit to me is the association with fellow engineers.
7 I believe I can take part as liaison between ASME and other professional societies.
8 Good fellowship within our own professional categories is important.
9 Your contribution of time or service will insure a return of satisfaction.
10 Because of the progressive field, ASME is a source of knowledge outside of immediate occupation and thereby a means of self development.

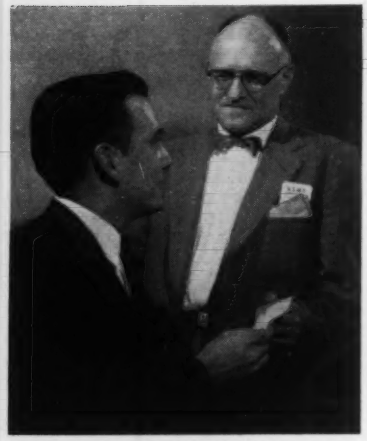
There were other questions and comments but the afore-mentioned will give an accurate cross section of this Section's thoughts, and convey them to other Sections in the ASME to help them sponsor a meeting of this type.

A well-deserved word of thanks should go to Thomas S. McEwan, National Chairman, Membership Development Committee and meeting chairman, who sparked the original idea, and to his committee: Clifford E. Evanson, vice-chairman; David S. Frank, program arrangements; Richard A. Holstedt, publicity; and Robert A. Nelson, hospitality; and to all who helped kick off this meeting as the first of its kind and worthy of being a standard for future annual new member meetings.

ASME Milwaukee Section Scholarship Activity

ON January 18 the chairman of The American Society of Mechanical Engineers Milwaukee Section, Allison K. Simons, presented to Erhardt C. Koerper, chairman of the Engineers Society of Milwaukee (ESM) Scholarship Committee, a check for $1000 to be used to aid students from the Wisconsin area in obtaining an engineering or scientific education. Behind this action lies the story of co-operation—of engineers with industry and among themselves.

In preparing for the ASME 1954 Fall Meeting held in Milwaukee, Wis., it was found



A $1000 scholarship check, to aid Milwaukee area students majoring in engineering or science, was presented to E. C. Koerper, *right*, scholarship chairman of the Engineers Society of Milwaukee, by A. K. Simons, chairman of the ASME Milwaukee Section, Wednesday, January 18, at the Milwaukee Athletic Club. ESM will seek further contributions and plans to assign an "engineering uncle" to each student recipient, to counsel him through the college of his choice.

necessary to solicit funds from industry in the area. In making the solicitation, the promise was made that "any surplus funds will be used for student assistance or professional development." The response was generous and the report of the Finance chairman following the meeting showed a surplus.

Mindful of their promise, the Fall Meeting committee and the executive committee of the Milwaukee Section hoped that the idea of student aid in the form of scholarships might be taken by other engineering societies and organizations in Wisconsin. In order to stimulate and provide for such a consequence the Section planned to entrust this fund to the Engineers Society of Milwaukee with the understanding that a suitable committee be set up to accomplish such a broad objective. The result was the formation of a permanent scholarship committee for the administration of aid to students and having broad legal and functional powers for attaining this end.

In addition to soliciting funds, selecting, screening, and designating students for scholarships, the committee has offered to serve as administrator for other scholarship funds.

The new committee is active and is getting results. The Wisconsin Academy of Science is co-operating on a statewide basis and will submit the names of worthy candidates who have demonstrated their abilities in science and engineering projects. Other societies have already indicated their interest in giving students help in their financial problems.

An unusual feature of this committee is that it keeps in personal contact with the recipient and his college adviser, and whenever possible appoints an engineering "uncle" to the student.

For further details contact E. C. Koerper, ESM Building, 3112 W. Highland Blvd., Milwaukee, Wis.

International Conference on Fatigue in Flight Structures Held at Columbia

Papers by 17 international authorities in the field of fatigue of metals in flight structures were presented at Columbia University's International Conference on Fatigue in Aircraft Structures, Jan. 30 through Feb. 1, 1956.

The conference provided theoretical and practical material upon which to reorient research in the design of modern aircraft. It was disclosed that accidents over a period of six years have frequently been the result of inadequate attention to fatigue engineering. Conventional design of aircraft for static load alone is obsolete and fatigue must be considered to avoid structure failure and accidents resulting from such failure.

The three-day conference, held in the auditorium of Havemeyer Hall, Columbia University, was attended by more than 150 engineers, scientists, and world authorities on this vital aspect of aircraft design from the United States and abroad.

The conference was presented in sessions covering physical theories of fatigue, fatigue testing in relation to design, and prevention of fatigue failure.

Physical Theories of Fatigue

In the discussion of mechanism of fatigue, W. A. Wood, University of Melbourne, Australia, said that it is not difficult to show that the crystalline structure of a metal responds differently to static and cyclic straining. The significant point is that the difference becomes marked when the amplitude of an alternating strain becomes less than a certain limit depending on the metal and its condition, so much so that the limit may be taken to define a reversible plastic set which proceeds by a special mechanism of deformation. He discussed fine and coarse slips. Special deformation need not strain-harden. One consequence is that mobile dislocations, continually producing fine-slip movements as they move to and fro, can go on building up intense bands of composite fine slip without the limitation that in static deformation would be imposed by strain hardening. The fatigue crack then appears as a further consequence of this uninhibited fine slip. The way in which it may do so was discussed in the light of the observations summarized in the paper.

The paper on "Mechanism of Fatigue in Pure Aluminum and Aluminum Alloys," by P. J. E. Forsyth of the Royal Aircraft Establishment, Farnborough, England, dealt with microscopical changes as they occur in pure aluminum, both annealed and cold-worked, and in age-hardening-type aluminum alloys.

N. Thompson of the H. H. Willis Physical Laboratory, University of Bristol, England, gave an account of experimental work done, independently, in the physics department of the University of Bristol and the metallurgy department of the Cambridge University. The two sets of experiments are compared with one another and with previous work and an attempt is made to set up a dislocation model which will account for the observations.

The relative insensitivity of the fatigue

Col. W. O. Davies, *left*, Deputy Commander, USAF Office of Scientific Research, Air Research and Development Command, Baltimore, Md., and Alfred M. Freudenthal, Mem. ASME, chairman, Organizing Committee for the International Conference on Fatigue in Flight Structures held at Columbia University, Jan. 30–Feb. 1, 1956.

properties of aluminum alloys to processes that improve their static strength has been investigated by measuring hysteresis during the progress of fatigue. Observations on the effects preceding fatigue failure of high-strength aluminum alloys were reported by R. F. Hanstock, High Duty Alloys Ltd., Slough, England.

The fatigue strength of steel, according to M. Hempel of the Max Planck Institute for Steel Research, Dusseldorf, Germany, is to a great extent influenced by the steelmaking, the mechanical treatment, and the preparation of specimens. Further, this strength depends on the qualities of a thin surface layer, i.e., grain size, surface roughness, strain hardening, and compression residual stresses. It is difficult to get specimens with the same mechanical and physical qualities, even when these are carefully annealed for stress relieving and electrolytically polished. To a great extent the fatigue strength of notched specimens is reduced by removal of a thin surface layer, which is disordered by the machining process.

Fatigue Life and Fatigue Strength

Further work on circular-section specimens containing, respectively, notches of various severities, has confirmed the previous finding that a fatigue crack is not the limiting case of a notch, as far as strength-reduction factors are concerned, according to C. E. Phillips of the Mechanical Engineering Research Laboratory, East Kilbride, Glasgow. It has been shown, he added, for the three materials tested, that there are minimum possible values of strength-reduction factor and that, even for a given material, it is most unlikely that a general relationship exists between theoretical stress-concentration effects and actual strength-reduction factors.

W. Weibull, professor of Bockamollan, Sweden, presented a paper entitled "Scatter of Fatigue Life and Fatigue Strength in Aircraft Structural Materials and Parts."

A. M. Freudenthal and R. A. Heller of Columbia University, described an experimental fatigue-testing machine that has been constructed in order to apply loading programs that can be made as representative of statistically specified service conditions as can reasonably be required. They discussed random fatigue tests and recent results of tests on AA 2024 and AA 7075 aluminium alloys.

The satisfactory prediction of the fatigue life of airplane structures has become an increasingly serious problem, observed E. Gassner of Laboratory for Performance Testing, Darmstadt, Germany. He discussed the present testing procedure and its most important parameters in the light of the experience gained in more than a thousand service fatigue tests on test specimens as well as on actual airplane and automobile structures and parts. The presentation of the test results as life or survivorship functions were analyzed with a view to facilitate their use by the designer. Finally, he said, some design rules will be emphasized which help to overcome the present uncertainties in the application in design of the results of fatigue tests.

Philip Brooks of Northrop Aircraft, Inc., Hawthorne, Calif., told of the active and potential role played by the individual aircraft company in the performance of fatigue research in his paper on "Structural Fatigue Research and Its Relation to Design." Two hypothetical types of airplanes are examined, he said, one a long-range interceptor and the other a medium-range transport. The complete engineering-design program is followed through for each; contrasting design philosophies plus differing requirements which affect fatigue characteristics are studied. The manner in which each portion of the design procedure defines the analytical and experimental fatigue research necessary was pointed out. The steps included in the paper were: The establishment of the mission criteria, the definition of the operational loading spectra, the establishment of design stress levels, the determination of detail design policy to be employed, the requirements for fatigue analysis and design testing and, finally, the necessary check testing of parts and components.

Harry T. Jensen of Sikorsky Aircraft, Bridgeport, Conn., told of the problems encountered in substantiating a helicopter for fatigue, with particular emphasis being placed on components that are unique to a helicopter such as rotor blades, hubs, and control systems. The schedule considers the following stages in the development of the helicopter and the relationship of each stage to the required fatigue substantiation: Design, evaluation, development, production prototype, and production development.

Fatigue Failure

Relationship between load spectra and fatigue life was discussed in detail in a paper by B. Lundberg and S. Eggwertz of the Aeronautical Research Institute of Sweden, Ulvsunda, Sweden.

Two papers were presented on fatigue testing for transport aircraft and the fatigue engineering of an aircraft. R. L. Schleicher, North American Aviation, Inc., presented a paper on the practical aspects of designing for satisfactory fatigue life in fighter and trainer-type aircraft. He summarized the type of information available to the aircraft-structures engineer to aid in his consideration of the fatigue problem and the various approaches to the problem. He gave a comprehensive summary of design practices. He concluded with the recommendation that, until a great deal more experience has been gained with the different methods of fatigue analysis now available, the most practical approach in design for high-fatigue life lies in repeated load testing of structural elements, representative of the full-scale air-frame component to a spectrum-type loading representative of the use of the aircraft.

Telling of the work being done at the Bristol Aeroplane Company, Ltd., Filton, England, H. Giddings gave a summary of the many types of fatigue-loading actions and drew particular attention to the importance of loads of once per flight frequency. The effects of operational variables on aircraft life, such as cruising height and climb and descent technique were discussed in relation to Bristol "Freighter" and "Britannia" aircraft. He stressed inspection and maintenance in relation to operational life. He gave some results of Bristol tests on the effect of "crack-stopper strips."

"Aspects of Fatigue Design of Aircraft Structures" was the subject of the concluding paper by F. Turner, Saab Aircraft Company, Linkoping, Sweden. He emphasized the value of the statistical approach and the use of the "return-period" diagram was illustrated. More precise definitions of the concepts "limit load" and "safety factor" were given. He said the basis of the factor of safety is scatter. This is not confined to material strength, but includes uncertainties in loads, and covering for some amount of error in design and manufacture. He discussed the difference in scatter for materials and for finished structures. He suggested that an ideal method of testing fatigue-sensitive parts would be the return-period test, which would automatically show whether fatigue or static strength is more critical.

The conference was jointly sponsored by Columbia University's department of civil engineering and engineering mechanics, its Institute of Flight Structures, and the Office of Scientific Research and Development of the United States Air Force. The Institute of Flight Structures, which was activated in 1954 at Columbia, is the result of a grant from the Daniel and Florence Guggenheim Foundation. Alfred M. Freudenthal, Mem. ASME, professor of civil engineering at Columbia, was chairman of the organizing committee.

Coming Meetings

Bituminous Coal Research

THE Third BCR Techno-Sales Conference and the annual meeting of Members of Bituminous Coal Research, Inc., will be held April 18 and 19 at the Deshler Hilton Hotel in Columbus, Ohio.

Industrial Research

INDUSTRIAL RESEARCH—its motives, its management, and its results—will undergo examination at the first annual National Industrial Research Conference. The conference, sponsored by Armour Research Foundation of Illinois Institute of Technology, will be held April 18 and 19 at the Sherman Hotel in Chicago, Ill.

Ohio State University Conference

ENGINEERS from coast to coast will consider the great problems facing the profession when they meet in Columbus, Ohio, on May 4, 1956, for the Third Annual Conference for Engineers sponsored by the College of Engineering of the Ohio State University.

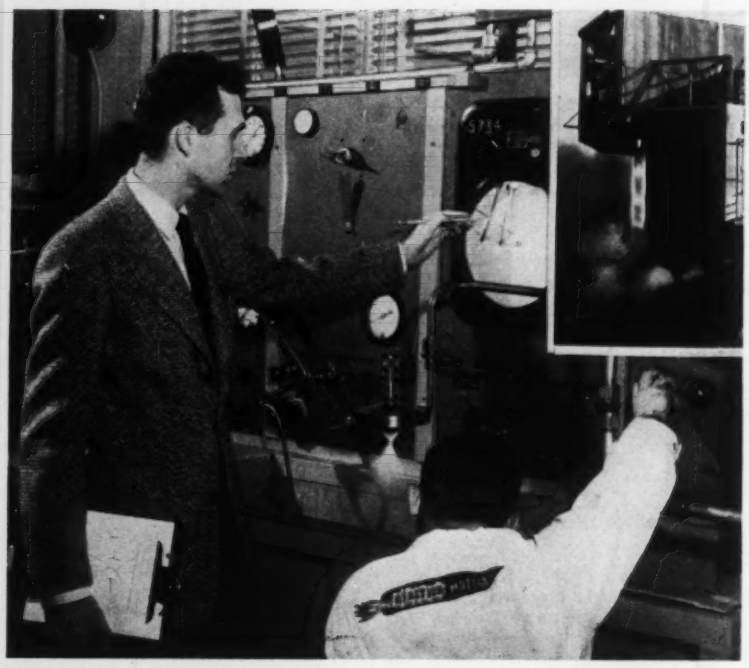
Atomic Energy for Industry

A TWO-DAY conference to alert business and commercial leaders of the Southwest and Mexico to the significance of atomic energy will be held at San Antonio, Texas, May 10–11, 1956. Southwest Research Institute of San Antonio will sponsor the conference in cooperation with the Atomic Industrial Forum.

Junior Forum

Conducted for the National Junior Committee

by R. A. Cederberg,[1] Assoc. Mem. ASME



Author, *left*, discusses performance of a new propellent injector being evaluated in the Reaction Motors, Inc., development laboratory. Insert shows firing of a high-thrust rocket engine in the RMI test area.

The Young Mechanical Engineer in Research and Development

By John A. Scheller[2]

DURING my last semester at Newark College of Engineering, Newark, N. J., I had to face the same problem now confronting many senior mechanical-engineering students: "Which of the hundreds of on-campus job interviews to sign up for and, from those, which job offer to accept?" This is really a desirable sort of problem to have, but it still requires evaluation and a decision. Ideally, each student would have a specific career objective in mind before he tackles this problem; however, I had none, and neither did most of my classmates. What I did have was a desire for technical challenge and the opportunity to do new things, come up with new theories, and invent new devices. Because research and development seemed to suit my objective, I obtained a position with Reaction Motors, Inc., Denville, N. J., pioneer developers of rocket engines for guided missiles and piloted aircraft.

Rockets—Past and Present

Although elementary-type rockets have been used for hundreds of years, only recently have advanced-type rocket engines been considered practical for uses such as supersonic aircraft, intercontinental missiles, and earth satellites. A vast store of technology has now been accumulated, and rocket propulsion has become a science in itself. The first step in this direction was the German V-2 program during World War II. More recently, the United States has taken even greater strides in the development of rocket propulsion. The use of rockets for jet-assist take-off (JATO) has become commonplace in military aviation, and the names of missiles such as Matador, Terrier, and Nike appear daily in our newspapers and magazines. The supersonic airplanes, intercontinental missiles, and earth satellites of today were made possible by the research and development programs of the past decade. The world's first piloted flight faster than sound was made in the Bell X-1, rocket-powered by RMI. Both the Bell X-1A and the Douglas "Skyrocket," present and past holders of the world's speed and altitude records for piloted aircraft, are powered by RMI rocket engines. The Martin "Viking" rocket set the existing speed and altitude records for single-stage rockets using RMI rocket power. I mention these records here to familiarize the reader with my company and to emphasize the vital nature of the contributions to national security being made by companies engaging in research and development.

My first assignment at Reaction Motors was in the development-engineering department, which consists of various sections, each specializing in a particular phase of rocket engineering and acting in a consulting capacity to the project-engineering department. The section to which I was assigned was the Valves and Controls Section, a group of specialists in engine-control systems and components. My job was to assist in the analysis of a control system being evaluated for the project-engineering department. Other sections of the development-engineering department specialize in pumps and rotating machinery, thrust chambers, propellent injection and ignition, and also physics and metallurgy.

Project Team

Following my work in control-system evaluation, I was assigned to the project-engineering department. For the performance of each new contract, a project team is organized and given full responsibility for getting the job done on schedule within a fixed budget. It is the project team that "carries the ball" and makes those crucial decisions upon which the success of every project hinges. I was assigned to a project team which had as its objective the design, fabrication, test, and field evaluation of an internal-combustion-type catapult power plant destined for use in launching aircraft. My job involved designing the electrical and hydraulic control systems and ordering the control equipment. I presently am engaged in technical liaison with the U. S. Navy concerning the control system for operating the catapult power plant at a naval base for field evaluation.

In a typical day there are few routines other than a morning cup of coffee, a lunchtime bridge game, and an afternoon ice-cream cone. The day itself is rather diversified, for research and development engineering is concerned with new and untried things rather than with established routines. I might start a day by studying the present method of operating some Navy machinery and then determine how that machinery could be operated in conjunction with our new catapult power plant. I then draw a schematic sketch of the resulting system, determine its size from flow and pressure-drop considerations, and list the addi-

[1] Westinghouse Electric Corp., Radio-Television Division, Metuchen, N. J.

[2] Engineer, Reaction Motors, Inc., Denville, N. J. Assoc. Mem. ASME.

ASME Membership

as of Feb. 29, 1956

Honorary Members	72
Fellows	402
Members	14,780
Affiliates	300
Associate Members (33 and over)	3,808
Associate Members (30-32)	4,440
Associate Members (to the age of 29)	17,405
Total	41,207

tional control equipment required, if any. The next step might be to arrange a one-day trip to a naval base to discuss this system. Later in the day an equipment sales engineer might stop in for a while to discuss the specifications I had written for a new piece of equipment. Another typical day might be spent entirely in conference with a consulting engineer on some aspect of the catapult-control system.

Of course, not every young engineer follows the same course as I have. Many young mechanical engineers have started in the test department at nearby Lake Denmark, N. J., where our rocket engines and their components are static-tested. Because of the extreme range of variables in rocket engineering and the high-performance levels being achieved, very accurate test data must be recorded. The latest instrumentation techniques and equipment are used, and test results are carefully analyzed and interpreted. The "hot" firing of a rocket engine is a thrilling experience (see photo insert) for everyone, particularly for the engineers who have contributed to its design. Other young mechanical engineers have started in the design department, which includes a Stress Analysis Section. Our rocket engines and related equipment are fabricated in our own Manufacturing Division where special processes are sometimes required.

Opportunities in Research and Development

Research and development (R&D) offers the young mechanical engineer a genuine personal challenge within a flexible organization where he will find a wide selection of opportunities for specialization and growth. He will discover that an R&D organization is staffed by high-caliber young men, because it thrives on the enthusiasm, imagination, and courage of minds which are unfettered by conventional approaches. There are no stereotypes and personnel policy is oriented toward recognition of individual ability and accomplishment. Performance on the job leads to bigger assignments and broader responsibility. The young engineer will find that an R&D organization pays better than other industries, both in starting salary and in the long run. Salary scales vary, however, among individual companies, and fringe-benefit packages must be considered in making comparisons. Much R&D effort is being devoted to the defense of our country and the free world, and the young engineer will find that significance of purpose is a factor not to be overlooked from the job-satisfaction standpoint.

Actions of the ASME Executive Committee

Meeting at Headquarters, March 2, 1956

A MEETING of the Executive Committee of the Council of The American Society of Mechanical Engineers was held Friday, March 2, 1956, in the rooms of the Society. There were present: Joseph W. Barker, chairman; F. L. Bradley, F. W. Miller, Louis Polk of the Executive Committee; H. J. Bauer, Finance Committee; J. L. Kopf, treasurer; E. J. Kates, assistant treasurer; W. H. Byrne, vice-president; H. C. R. Carlson, R. B. Lea, Joseph Pope, directors; C. E. Davies, secretary; D. C. A. Bosworth, T. A. Marshall, Jr., O. B. Schier, 2nd, assistant secretaries; and Ernest Hartford, consultant. The following actions are of general interest:

EIC Member Elected to ASME

William C. Leith of The Engineering Institute of Canada was elected to associate membership in the ASME and under the reciprocal arrangement with EIC (and until the ASME By-Laws providing for this will become effective June, 1956), the Executive Committee of the Council authorized reduction in dues payment for 1956 to provide equivalent of waiving the initiation fee.

Board on Membership

Upon recommendation of the Membership Review Committee, concurred in by the Board on Membership, it was voted to authorize the following guide for the Membership Review Committee, each case to be acted upon individually by the Board on Membership and the Executive Committee, for members of long standing who have been judged worthy of special consideration, not qualified to be dues-exempt, and who tender their resignation because of inability to pay dues, due to retirement or ill health.

To carry these members on the Society's roll of membership under one of the following two provisions: (*a*) Members expressing the desire to retain the grade of Member be continued in that grade without payment of dues, and without further services of the Society except that they shall be carried as paid-up members within the Section in which they reside; and (*b*) Members expressing the desire to receive limited services be continued in the grade of Member and by an annual token payment of $5 receive MECHANICAL ENGINEERING and such other services as the Council may direct.

Meetings Committee

The Meetings Committee set up the following meetings and conferences, as authorized by the Board on Technology:

Gas Turbine Conference and Exhibit, Hotel Statler, Washington, D. C., April 16–18, 1956.

Participation of Materials Handling and Rubber and Plastics Divisions in the Industry-Military Conference on Materials Handling of Plastics, Washington, D. C., week of March 26–30, 1956.

Participation in the American Power Conference, Chicago, Ill., March 21–23, 1956.

Metals Engineering Conference, jointly with American Welding Society, Hotel Statler, Buffalo, N. Y., May 8–10, 1956.

Petroleum Conference, Statler-Hilton, Dallas, Texas, Sept. 23–26, 1956.

Heat Transfer Conference, The Pennsylvania State University, University Park, Pa., week of Aug. 11, 1957.

Annual Meeting, Chalfonte-Haddon Hall Hotel, Atlantic City, N. J., Nov. 29–Dec. 4, 1959.

Membership Development Committee

The problem of travel expenses for Regional Chairmen of the Membership Development Committee was discussed by the Executive Committee on Dec. 2, 1955, and referred to the Finance Committee and the vice-presidents for recommendation. Report of the Finance Committee action was made at the Feb. 3, 1956, meeting of the Executive Committee and action was withheld until this problem was considered by the vice-presidents.

Upon the recommendation of the vice-presidents, the Executive Committee of the Council voted that mileage on the basis of 13 cents a mile and $6 per diem be provided for the chairman and the vice-chairman of the Membership Development Committee, and all the Regional MDC chairmen, to attend only the Semi-Annual Meeting in Cleveland, June 17–21, 1956; that an appropriation of $1200 be set up for this meeting; and that the effectiveness of attendance at the meeting be reviewed critically by the vice-presidents.

Boiler and Pressure Vessel Committee

The Secretary reported a request from an industrial association in Brazil for permission to translate the Pressure Vessel Code into Portuguese. The safeguarding of the Code was considered at some length, particularly in regard to assuring the accuracy of the translation and the need for maintaining such a Code up to date. The Executive Committee felt that there was the possibility of further translations of ASME codes and standards into foreign languages and voted to assign to the Board on Codes and Standards the responsibility for granting authority to responsible bodies to sponsor translations of ASME codes and standards into foreign languages and to insure that proper safeguards are established to cover the accuracy of the translations and the maintenance of the codes and standards in an up-to-date condition.

Public Relations Committee

Upon the recommendation of the Public Relations Committee and with the concurrence of the Finance Committee it was voted to

authorize an immediate allocation of $10,000 for the public-relations program pending the submission and acceptance of a final report.

International Electrotechnical Commission

The ASME is represented on the U. S. National Committee of the International Electrotechnical Commission and holds the secretariat for three technical committee projects—Hydraulic Turbines, Steam Turbines, and Internal-Combustion Engines, the chairmen of which are, respectively, S. Logan Kerr, A. G. Christie, and Paul Diserens. The first two of these technical committees are holding meetings in Munich, Germany, June, 1956. These projects are closely related to similar projects of the ASME Power Test Codes Committee and the personnel in each project is the same.

The ASME has contributed some staff support for the IEC work on these three technical projects but the expense of providing attendance at the meetings of these committees has usually been provided by industries which are concerned with the work of the technical committees. The Secretary read a communication from S. Logan Kerr pointing to the fact that support for U. S. A. attendance at the Munich meeting of TC/4, Hydraulic Turbines, was uncertain at the moment and as it was necessary for him to make travel plans at once he requested the Executive Committee for support. It was subsequently learned that financial support has been forthcoming. It was voted to request the Board on Codes and Standards to review the long-range policy of the Society with respect to participation in the IEC activities.

Technology Executives Conference

The Executive Committee on Feb. 3, 1956, discussed the Technology Executives Conference which was held in Ann Arbor, Mich., Jan. 30–31, 1956, and requested the Secretary to consider the suggestions made at the meeting for enlarging this Conference and to make recommendations.

The Board on Technology has decided to hold the 1957 Conference at Arden House, Harriman, N. Y., Jan. 7–8. It was voted to recommend that the usual meeting of the vice-presidents, held early in the calendar year, and the meeting of the Executive Committee for January be held at Arden House during the Technology Executives Conference, to enable the vice-presidents and the members of the Executive Committee to become more familiar with the important work of the committees which are responsible for the technical life of the Society.

Sections

The Mexico Section, since its establishment in 1951, has been functioning on a three-year basis, only one delegate attending the Regional Administrative Committee meetings. Upon recommendation of the Vice-President, C. H. Shumaker, the Executive Committee of the Council voted to authorize the establishment of the Mexico Section on a permanent basis, Vice-President C. H. Shumaker to report at the June Council meeting on the matter of attendance of two delegates from the Mexico Section to the 1957 RAC meeting, a problem which is related to the rate of dues paid by the members in Mexico.

Upon recommendation of Vice-President F. W. Miller, concurred in by the other vice-presidents, it was voted to authorize full Section status for the State-Line Subsection of the Buffalo Section, the territory to include the Counties of Allegany and Cattaragus in New York and McLean County in Pennsylvania, the place of meeting to alternate between Olean and Wellsville.

The Executive Committee suggested that consideration be given to a change of name for the State-Line Section because the name is not definitive.

Upon recommendation of Vice-President A. C. Pasini, it was voted to authorize the establishment of a Johnstown Group of the Westmoreland Section, the territory to include Cambria County, and the place of meeting to be Johnstown, Pa.

Regional Administrative Committee Delegates

It was voted to rescind the action of the Council on Nov. 13–14, 1955, whereby the rate for travel to RAC meetings was reduced to 11 cents per mile, and to restore the mileage rate for the 1956 RAC delegates to 13 cents per mile.

ASME Motion Picture

The Secretary reported ten bookings of the ASME motion picture on television to an audience of 854,739, and 18 bookings for group showings to an audience of 4236. Fifty-six group showings to an audience of 7767 have previously been reported.

Certificates of Award

Certificates of Award were granted to the following retiring chairmen: Savannah Section, Virgil G. Hall; Peninsula Subsection of Virginia Section, R. Hial Pepper. Approval was voted of a certificate to the charter members of the Mid-Hudson Section, to be signed by the Section chairman, as a token of appreciation to those who were active during the formation period. A revised policy on the granting of Certificates of Award was approved.

Students and Student Branches

The vice-presidents, at their meeting Feb. 24–25, 1956, discussed the various means of distributing the $5000 authorized by the Council, Nov. 13–14, 1955, for the expenses of faculty advisers attending the Regional Student Conferences. Upon recommendation of the vice-presidents, it was voted to amend Par. 11 (*b*) of the Budget Policies adopted June 19, 1955, to read as follows:

"For Student Branch Conferences—'To Faculty Adviser, 11 cents per mile one way (calculated by standard railroad route) plus $6 per day or major part thereof for time engaged in the Conference and for trip over 100 miles for travel time to and from the meeting not to exceed round-trip travel time by standard railroad route.

'To Faculty Advisers in metropolitan area who do not travel over 100 miles, $6 per day or major part thereof for time engaged in the Conference plus a miscellaneous allotment of $3.

'To the Student delegation, 18 cents per mile one way (calculated by standard railroad route).

'Payment for the Faculty Adviser and the payment to be used by the Student Delegates will be made in separate checks and sent to the Faculty Adviser. If the Faculty Adviser or his representative does not attend that check is to be returned.'"

The Council, on June 28–29, 1953, upon recommendation of the vice-presidents voted "to approve the designation of Student Branch Councilors as appointive officers of the Sections, one for each Student Branch in the area of the Section." The vice-presidents discussed the usefulness of the Student Branch Councilor, and upon their recommendation, the Executive Committee of the Council voted to rescind the action of the Council on June 28–29, 1955, designating Student Branch Councilors as appointive officers of the Sections and to make the appointment of a Student Branch Councilor optional by the Section, with the advice of the vice-president and the faculty adviser.

Upon recommendation of the vice-presidents, it was voted to continue the Student Branch at the University of Puerto Rico for another scholastic year ending June, 1957.

Gantt Medal Board of Award

The basis for the Gantt award as stated in the deed of gift is "for distinguished achievement in industrial management as a service to the community." The Gantt Medal Board is desirous of removing the word "industrial" from the deed of gift and voted to recommend to the supporting societies (ASME and American Management Association) that the deed of gift be modified accordingly. The Executive Committee of the Council voted to approve the omission of the word industrial and to suggest that the basis for the award read: "for distinguished achievement *and* service to the community." This will require the approval of the other participating body, the American Management Association, and the Gantt Medal Board of Award.

At a meeting on Feb. 14, 1956, the Gantt Medal Board of Award considered the possibility of expanding the usefulness of the Gantt award by bestowing Citations of Achievement on individuals who have made outstanding contributions in various areas of management but who may not be eligible for the Gantt Award. The Board voted to recommend this action to the supporting bodies. The Executive Committee of the Council voted to authorize the granting of a Citation of Achievement "in the various fields of competence within the general area of the Gantt award and in accord with the spirit of the award."

Verein Deutscher Ingenieure

The Executive Committee designated Robert

C. Allen and Brig. Gen. Stewart E. Reimel to serve as Honorary Vice-Presidents at the centennial celebration of the VDI, in addition to the four members designated at the Feb. 3, 1956, meeting.

W. F. Durand

The Secretary reported that William F. Durand, past-president and Hon. Mem. ASME, would celebrate his ninety-seventh birthday on March 5, and the Executive Committee designated Robert B. Lea to convey to Dr. Durand, personally, congratulations and greetings on behalf of Council, officers, and staff.

Celebration of 250th Anniversary of Birth of Benjamin Franklin

In 1954 the Society was invited by the Engineers' Club of Philadelphia to participate in the celebration of the 250th anniversary of the birth of Benjamin Franklin. The Executive Committee authorized participation and approved also a resolution for inclusion in the 1955 brochure on "Plan for the Celebration." The Secretary reported that the Poor Richard Club of Philadelphia presented to the Society its Almanack Medal and a Certificate "for distinguished service in the 250th anniversary of the birth of Benjamin Franklin," in appreciation of the Society's "constructive leadership in suggesting co-operation by local chapters of ASME which resulted in excellent programs in many sections of the country."

Death of Mrs. Calvin W. Rice

The Secretary reported the death on March 1, 1956, of Mrs. Calvin W. Rice, widow of Calvin W. Rice, who died in 1934 and who served the Society as Secretary from 1906 to that date. The Executive Committee directed that its deepest sympathy be extended to Mrs. Rice's family.

ASME Codes and Standards Workshop

Boiler and Pressure Vessel Code

A MEETING of the Boiler and Pressure Vessel Committee of The American Society of Mechanical Engineers will be held jointly with the National Board of Boiler and Pressure Vessel Inspectors, June 19 to 22 inclusive, at the Windsor Hotel, Montreal, Que., Can.

The meeting will include a panel session on all the various sections of the ASME Boiler and Pressure Vessel Code, which will include, in part, power boilers, heating boilers, unfired pressure vessels, and welding requirements. Meetings of the various subcommittees are also planned. There will be a discussion on "National Board Rules for Repair."

A dinner dance will be held on Thursday and the all-day session of the Boiler and Pressure Vessel Committee is planned for Friday.

The Engineering Institute of Canada, representatives from both the Boiler and Pressure Vessel Committee, and local members of the National Board of Boiler and Pressure Vessel Inspectors comprise the Planning Committee.

New Appointment. Wayne G. Henderson, superintendent, Engineering and Loss Control Division, Travelers Indemnity Company, was appointed to membership on the Main Committee.

Power Test Codes

The Power Test Codes Committee announced the election of Rawleigh M. Johnson, engineer in charge, engineering test department, Ingersoll-Rand Company, Phillipsburg, N. J., as chairman of the committee, succeeding A. G. Christie, past-president and Hon. Mem. ASME.

Power Test Code Committee 28 on Measurement of Small Particulate Matter

By W. A. Crandall, Chairman

When the Power Test Code for Dust Separating Apparatus was prepared over 15 years ago, equipment was bought and sold on the basis of specifications for over-all collection efficiency.

With the increase in boiler size and complexity and new developments in dust-collector design, it became necessary to relate the performance of dust-collecting apparatus to the physical and electrical properties of the material to be collected. Hence the individual equipment manufacturers developed various test methods for the determination of particle-size distribution, electrical resistivity, and so on. Unfortunately, however, this resulted in a situation whereby each manufacturer was using different test procedures and nomenclature, resulting in a maze of performance data, equipment specifications, and the like, which could not be adequately correlated by the purchaser of the equipment. As a result, much confusion developed in specifying the desired performance of equipment to be purchased and evaluating the performance of equipment already in operation.

To alleviate this situation, various co-operative efforts were undertaken by manufacturers of dust-collection equipment, public utilities, and other interested organizations. The need for standardization in respect to test procedures and nomenclature was recognized by all concerned. These efforts resulted in the formation of Power Test Code Committee 28, which has as its objective the study and evaluation of methods for determining the particle-size distribution of fine particulate matter and the eventual preparation of a code which will define the test methods and nomenclature to be used in respect to particle-size distribution as it relates to dust-collection equipment. The Committee is composed of personnel experienced in this field, representing equipment manufacturers, public utilities, research organizations, and other groups concerned with this problem. Although the major endeavor of the Committee will be in the field of dust collection, it is believed that the results of the Committee work will prove of value to those working in other fields of fine-particle technology.

Standardization in the Field of Nuclear Energy

Areas of possible standardization in nuclear work have been broken down into seven groups: (1) general standards, such as nomenclature, color codes, symbols, and qualifications; (2) standards for radiation protection, both for people and for property; (3) standards for nuclear safety, in operation and processing; (4) materials and properties, including mining and metallurgy; (5) standards for equipment in the mechanical and civil-engineering fields; (6) standards for equipment in the electrical field; and (7) standards for processes, including chemical engineering. H. A. Wagner, Detroit Edison Company, was named chairman of the planning subcommittee on standards for equipment in the mechanical and civil-engineering fields, as alternate for F. S. G. Williams. A meeting of this planning subcommittee was held Feb. 22, 1956, and a set of recommendations prepared which has been circulated to a number of selected individuals for comment. In general, the subcommittee recommended that where existing standardizing projects existed in any of the areas, the question of including nuclear work in such projects should be referred to the sponsors of the projects.

Identification of Piping Systems

By W. H. Evans, Chairman, Sectional Committee A-13

Colors, either solid or in combination, have probably always been used for various identification purposes. In the early days some compressed-gas tanks were painted various colors, not to identify the contents but to indicate ownership of the tanks. The result was many different-colored tanks that contained the same material. This has proved extremely dangerous in many instances.

As more and more materials, some hazardous and some not, were piped to points of use in various establishments, it became apparent that some systematic means of identification was imperative.

Many industries formed their own color schemes, giving no thought, of course, to standardization outside the individual plant. Considerable confusion resulted due to the use of many schemes even within one plant of the same company. This created additional hazards.

Schemes for the identification of piping sys-

tems developed by industrial plants of various kinds, in many instances worked well within the plant. Generally speaking, they probably gave a great deal of satisfaction; however, they had one common fault—they suffered from lack of uniformity. Mistakes were made turning valves of disconnecting pipes at the wrong time. This caused accidents and, in many cases, injury. Many times municipal fire departments were called in to fight fire and they had no knowledge whatsoever of the color scheme within the plant. There are many instances of serious injury occurring because of this. It was apparent that some scheme be devised that had flexibility, simplicity, and distinguishability in order to eliminate the confusion that now existed.

The organization of the Sectional Committee on the Identification of Piping Systems, under the procedure of the American Standards Association, took place on June 14, 1922. The National Safety Council and The American Society of Mechanical Engineers are joint sponsors for this project and the Committee presently consists of 37 members representing 28 technical societies and industrial organizations.

After considerable hard work, the first standard was approved in 1928. It was reaffirmed in 1947. In 1951 the Committee was reactivated and the code was revised in its present form.

In the new standards the color "purple" was purposely dropped as a distinguishing color for so-called "valuable material." Another difference in this revision is the provision for the identification of the contents by legend. This, in the opinion of the Committee, was necessary because of the difficulty in striping, and the fact that eventually one runs out of colors. The basic colors that were chosen are so far apart on the spectrum that considerable variation in shade could occur and the actual colors intended would still be recognizable. It was the Committee's opinion that the legends will definitely identify the material.

The appendixes that were in the original code were dropped because in many cases they were not complete and the determination of whether or not a material was safe or unsafe depended to a certain extent upon the use to which it is put. In general the Committee urges the doctrine that once dangerous always dangerous. For instance, some fire-quenching materials are dangerous for other uses.

It is to be noted that the main classification is by the four colors:

Class	*Color*
F, Fire-protection equipment	Red
D, Dangerous materials	Yellow (or orange)
S, Safe materials	Green (or the achromatic colors, white, black, gray, or aluminum)
P, Protective materials	Bright blue

Red has been assigned because of its long-established use on fire-fighting and protective equipment. Yellow and orange were reassigned to dangerous materials because they have the highest coefficient of reflection under white light and can, therefore, be more readily recognized under the poorest conditions of illumination. Green has been the universal color used for safety and was left that way as was the bright blue for protective materials. Not too much change was made because of the possible opposition of industry to adopt any radical changes.

If enemy action ever lays waste to some of our industry, it is possible that the damage can be minimized if Civil Defense personnel, plant defense personnel, Red Cross Rescue Squads, and other defense personnel are able to follow an established code in knowing which valves to open or close.

Slotted and Recessed Head Screws

Revision of the American Standard Slotted and Recessed Head Screws, ASA B18.6-1947, has brought about a separation of the previous standard into four parts, the first of which, Slotted and Recessed Head Wood Screws, has just been approved as an American Standard.

As presently planned, the complete revision of B18.6-1947 will be accomplished when all of the following four standards are approved:

1 Slotted and Recessed Head Wood Screws, B18.6.1
2 Hexagon and Slotted Head Cap Screws, Square Head Set Screws, and Slotted Headless Set Screws, B18.6.2.
3 Slotted and Recessed Head Machine Screws, B18.6.3.
4 Slotted and Recessed Head Tapping Screws and Metallic Drive Screws, B18.6.4.

The honorary award of fellowship in the Standards Engineers Society was presented to U. S. Senator Ralph E. Flanders of Vermont, past-president and Hon. Mem. ASME, at a special meeting of the Washington Section, Jan. 11, 1956. The award was made by Madhu Gokhale, *second from left,* president of the society, and William L. Healy, *left,* past-president and acting chairman of the awards committee. Roger E. Gay, *right*, Director of Cataloging, Standardization, and Inspection in the Department of Defense and past-president of the American Standards Association, assisted in the presentation, which took place in the Caucus Room of the Senate Office Building. After the award, Senator Flanders reviewed his experiences in standardization. Starting from a period early in this century when special screw threads were the style, the Senator outlined progress in standardization up to establishment of the series of unified screw threads adopted by the United States, Great Britain, and Canada. Senator Flanders stated that proper standards were basic to the national economy. They help increase the standard of living through increased production. Standards relegate problems which are already solved to the field of the routine, leaving the creative talent of designers free for the consideration of other aspects.

The revised data on square and hexagon cap and set crews have been deleted from B18.2-1955, Square and Hexagon Bolts and Nuts, and will appear in B18.6.3.

Parking Devices

The ASME has accepted sponsorship of a project on a Safety Code for Parking Device Equipment. The project grew out of a subcommittee of the Sectional Committee on a Safety Code for Elevators, A17. This subcommittee, composed of elevator, insurance, and parking-device men, prepared a draft of rules for the elevator part of such devices, but after completion of the draft recommended to the Sectional Committee that a separate project on the devices be formed. In this way the tower structure could be covered. It was the feeling of the subcommittee that an adequate safety code could not be prepared without including the tower. The A17 Executive Committee agreed with this opinion, and in addition stated their belief that it would not be desirable to enlarge the scope of the Elevator Code Committee to include structural features as described. Upon request by the Society, a general conference, called by the American Standards Association, recommended that the project be set up, that the Society be asked to sponsor it, and that the scope of the project be:

"This safety standard shall cover mechanical and electrical equipment that moves motor vehicles vertically and/or horizontally to and from a parking location, excluding elevators in structures where the vehicles are parked under their own power in any unoccupied space on a given parking level."

Any individuals or groups interested in participating are invited to write to ASME Codes and Standards Service for more information.

Air-Pollution Control

The first meeting of Sectional Committee Z74 on Fundamentals of Performance of Effluent Air and Gas Cleaning Equipment was held Feb. 7, 1955. The ASME is administrative sponsor, and the American Society of Heating and Air-Conditioning Engineers is cosponsor for the project.

At the meeting, the chairman, Allen C. Brandt, Bethlehem Steel Company, Bethlehem, Pa., appointed a subcommittee to prepare an outline of presentation, for consideration by the Sectional Committee. Andrew H. Rose, Jr., Robert A. Taft Sanitary Engineering Center, is chairman of the subcommittee.

The Sectional Committee voted to recommend that its scope be clarified to read:

"Standards relating to the fundamentals of performance of effluent air and gas-cleaning equipment or devices used for the treatment of process effluent prior to its discharge to the atmosphere."

New American Standards Published

Letter Symbols for Chemical Engineering, ASA Y10.32-1955. Revision of the previous 1946 standard.

Scheme for the Identification of Piping Systems, ASA A13.1-1956. Revision of the previous standard, which was reaffirmed in 1947.

Slotted and Recessed Head Wood Screws, ASA B18.6.1-1955. Revision of part of ASA B18.6-1947, covering wood screws only.

20-Deg Involute Fine-Pitch System for Spur and Helical Gears, ASA B6.7-1956. Revision of the previous 1950 standard.

Inspection of Fine-Pitch Gears, ASA B6.11-1956. Revision of the previous 1951 standard.

Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., in co-operation with the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to all engineers, members or nonmembers, and is operated on a nonprofit basis.

In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrant members whose availability notices appear in these columns. Apply by letter, addressed to the key number indicated, and mail to the New York office.

When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available at a subscription of $3.50 per quarter or $12 per annum for members, $4.50 per quarter for nonmembers, payable in advance.

New York	Chicago	Detroit	San Francisco
8 West 40th St.	84 East Randolph St.	100 Farnsworth Ave.	57 Post St.

Men Available[1]

Top Engineering Position, MSME; 35 years' experience; design and development; electromechanical apparatus, stainless-steel fabrication, heavy machinery; provide ideas in addition to supervision of department. ME-290.

Engineer, Physicist, Mathematician, DS, 44, 16 years' experience research, development; performance, administration; automatic machinery, electromechanical systems, instruments. Excellent knowledge production methods. Prefers northeast U. S. A. or Near East (knowledge of languages). ME-291.

Mechanical Engineer, 28, BME, married. Five years' industrial experience, one assisting management of electrical components manufacturer, four in technical service and design with job-shop parts manufacturer. Desires position involving planning and co-ordination of production and design with diversifying or expanding company in southeast Conn. or N. Y. ME-292.

Positions Available

Research Assistants, full or part-time employment, on projects in mechanics with emphasis on elasticity, vibration, and electrical instrumentation. Experience in applied mathematics or electromechanics desired. Opportunity for graduate study commensurate with research duties available in engineering mechanics, civil engineering, mechanical engineering, and applied mathematics. To $6000 for full time for ten months' employment. Fla. W-2848.

Chief Engineer, 30–50, experience in mechanical design. Some knowledge of nonferrous metallurgy, aluminum, copper, bronze, etc. Company manufactures electrical conductor fittings. $10,000 plus. Pa. W-2944.

Engineers. (*a*) Administrative superintendent, 33–40, college graduate, preferably engineering degree, five to ten years' experience in production, preferably nonferrous fabricating plants with rolling-mill equipment. Calif. (*b*) Senior industrial engineer, 25–35, industrial experience in methods analysis and plant layout. Should have experience in rolling of aluminum sheet, hot and cold-rolling mills with attendant remelt operations. State of Washington. (*c*) Chief industrial engineer, 28–40, experienced in rolling of aluminum sheet. Hot and cold mills with attendant remelt operations; also method analysis of production operations, develop cost studies, determine capacities, and have responsibility for plant layout. Salaries open. State of Washington. W-2947.

Designer, paper machinery, for research and development department. High-speed machinery-design and welding-design experience desirable. Work will include revolutionary designs as well as current developments in formation, mechanical water removal, and drying of paper. Salary commensurate with experience. New England area. W-2965.

Assistant Manager of Purchasing, 40–45, college graduate, at least 15 years' heavy-industry experience and at least four years' top administrative responsibility for purchasing functions over multiplant heavy industry. Experience in steel, heavy chemicals, or aluminum industry desirable. Should be a member of National Association of Purchasing Agents. Salary open. West Coast. W-2966.

Assistant General Manager, 40–50, experience in heating-equipment or gas-appliance industry and sales. Company manufactures domestic hot-water heaters and a general line of heating equipment. Canadian citizen only. $10,000–$12,000. Toronto, Ont., Can. W-2977.

Vice-President, graduate engineer, thoroughly familiar with problems concerning the compressor business. Will be required to organize, develop, and direct an entire compressor division. Salary open, plus bonus. Excellent opportunity. Midwest. W-2979.

Director of Industrial Sales, 35–50, responsible for planning, developing, and administering all original equipment sales in the manufacture and distribution of parts used in autos, trucks, marine motors, pumps, road machinery, stationary engines, railroad, and aviation equipment. $20,000, plus bonus. Midwest. W-2981.

Chief Product Engineer, mechanical degree, or equivalent, minimum of ten years' experience in design and development; must be able to work with people in directing the design and development of semiautomatic electromechanical equipment and must be able to assume administrative responsibilities. About $10,000. Upstate N. Y. W-2985.

Plant Engineer, 35–40, mechanical graduate, at least ten years' experience in process manufacturing in coated products, rubber, plastics, or allied fields. $8400–$10,800. N. J. W-2986.

Staff Engineering Assistant, young, mechanical graduate, design and layout experience in plant engineering fields covering heating, ventilating, piping, and building layout for textile manufacturer. $5200–$6500. New York, N. Y. W-2987.

[1] All men listed hold some form of ASME membership.

Engineers. (*a*) Project engineer, graduate mechanical, thorough knowledge of thermodynamics, heat transfer, with refrigeration experience preferred. To $10,000. (*b*) Production manager, mechanical graduate, knowledge of thermodynamics, heat transfer, with refrigeration experience preferable. Experience in job-shop operation. To $8000. Conn. W-2997.

Mechanical Engineer, graduate, about 40, some experience in industrial engineering, for process-development work and production. Company manufactures plastic molding and materials and plastic-packaging film. $7000–$9000. Northern N. J. W-3002.

Teaching Personnel. (*a*) Instructor, with or without MS degree in engineering; experience desirable but not essential. Will teach engineering drawing and descriptive geometry. (*b*) Assistant professor, MS also with industrial and teaching experience, to teach machine design, lecture, and laboratory; kinematics of machines; applied graphic statics and engineering drawing. (*c*) Assistant professor, MS, some experience. Will teach engineering drawing and descriptive geometry. Salaries will depend upon training and experience. Positions begin September, 1956. South. W-3014.

Management-Conference Leader, graduate engineer, experience in industrial management, to conduct seminars and conferences on management problems throughout the East and Midwest. $9000. Headquarters, Midwest. W-3020.

Maintenance Engineer, mechanical-engineering training, plant engineering, and maintenance experience covering construction and mining equipment, diesel, and hydroelectric plant. Must speak Spanish. Salary open. Colombia, S. A. F-3023.

Director of Research and Engineering, experience in the design and development of mechanical, electrical, or electromechanical devices and production; strong background in research, engineering, and product development in a fast-moving company, preferably in commercial products. New York, N. Y. W-3028.

Engineers. (*a*) Sales engineer, 36–50, engineering training and export selling experience in U. S. and abroad, preferably Latin America, to prepare engineering estimates and negotiate contracts for alloy-steel pressure vessels, heat exchangers, fabricated piping, pumps, and accessories. (*b*) Sales engineer, 26–35, preferably with export experience in heavy-process-equipment fields. Salary open. Locations: (*a*) Foreign; (*b*) Midwest. W-3053.

Systems and Methods Engineer, 30–35, industrial-engineering degree and at least five years' experience in heavy industry, areas of systems and procedures, costs and cost accounting, wage incentives, and inequity programs, office automation, etc. Salary open. Calif. W-3064.

Engineers. (*a*) Assistant safety supervisor, degree, under 35, three to ten years' experience in industrial plants handling industrial safety problems. Will assist in promoting effective safety and housekeeping program. Salary open. Pacific Northwest. (*b*) Senior industrial-relations representative, under 35, five to ten years' experience in the labor movement, preferably in the employ of an international industrial-type union. Experienced in handling grievances and labor-contract administration, and/or negotiations; or five to ten years in industrial relations or labor relations in an industrial plant. Salary open. Pacific Northwest. W-3066.

Engineers. (*a*) Industrial engineers, graduate mechanical or industrial, preferably with minimum of five years' experience on materials handling, plant layout, wage incentive, and piece rates with particular emphasis on statistical application as applied to textiles. $7500–$9000. Ga. and Montreal, Que., Can. (*b*) Industrial engineer with experience similar to afore-mentioned. Considerable travel out of home office. $7500–$9000. Headquarters, New York, N. Y. W-3073.

Sales Manager, 36–40, engineering background and experience in all phases of sales administration, i.e., training, market analysis, advertising and promotion, and some knowledge of defense contract work. Will co-ordinate sales activites and policies for multiplant organization with diverse technical and consumer markets. $30,000–$40,000. Headquarters, N. Y. metropolitan area. W-3074(*a*).

Manufacturing Engineer, mechanical, electrical, or industrial graduate, at least three years' methods and assembly experience in electronic or electromechanical fields. Salary open. Calif. W-3075.

Industrial Engineer, 30–40, industrial or mining-engineering graduate, at least five years' supervisory production methods, cost accounting, and incentive experience in coal mining. $10,000–$12,000. W. Va. W-3077.

Chief Industrial Engineer, 30–39, college graduate, preferably industrial engineering, but will consider general or mechanical engineering, or BA, ten years' experience in heavy industry with operations such as blast furnace, electric furnace, base-metal smelter, or open hearth and experience in cost-reduction programs as related to the industrial-engineering field. Must have broad background in materials handling, manpower utilization, methods, and controls. Salary open. State of Washington. W-3080.

Sales Engineer, 30–40, preferably mechanical, to sell equipment for company manufacturing corrosion-resistant heat-exchange units used for both heating and cooling, a complete line of corrosion-resistant ventilation equipment for the handling of corrosive fumes, and a complete line of specialized tank equipment used for chemical service. N. Y. metropolitan area. W-3081.

Engineers. (*a*) Merchandising manager, 35–45, college graduate, minimum of ten years' experience in general merchandising with emphasis on industrial light-gage metal sales. Should be familiar with consumer-advertising media, consumer selling, and market techniques. District or home-office level administrative and supervisory experience a must. (*b*) Technical service engineer, 28–36, mechanical, chemical, or ceramic engineer, four to five years' industrial experience in glass, steel, cement, refractories, or copper industries. Some knowledge of production and/or process-control work in the above industries desirable. Salaries open. West Coast. W-3082.

Division Manager of Development and Production Technical Service, BS in mechanical, electrical, or chemical engineering or physics, five years' or more experience connected with electronics components. Will administer the development and production of technical service and will be responsible for planning, organizing, and directing the development program. $11,000. Pa. W-3085.

Product Manager, Supplies Division, graduate chemical, or major in chemistry or mechanical; 35–45, for production control for manufacturer of duplicating equipment such as carbon paper, duplicating fluid, etc. $12,000–$14,000. Chicago, Ill. C-4597.

Methods Engineer, mechanical or industrial graduate, to 50, at least five years' experience in light manufacturing industry. Will do methods and production studies for a tobacco manufacturer. $10,000–$12,000. Employer will negotiate fee. W. Va. C-4620.

Manufacturing Engineer, graduate mechanical, to 45, at least three years' experience in production work on air-conditioning equipment. Knowledge of quality control. Will analyze manufacturing, plant, tooling, establish methods, plant layouts, check materials operations and designs, and initiate change orders of design. Travel, temporarily, 50 per cent of time. $6600–$9600. Chicago, Ill. C-4632.

Sales Manager, Boilers, 50–65, at least five years' experience in sales of boilers, stokers, or other combustion equipment. Will supervise national boiler sales through some dealers but mostly direct home-office contacts with industrials. Some travel. $8000–$10,000. Employer will negotiate fee. Ill. C-4673.

Production Supervisor, mechanical graduate, 38–45, 15 to 18 years' experience in tool and dies, some time-study and rate selling, scheduling, etc. Knowledge of mass production and equipment. Should know forging, heat-treating, grinding, and polishing operations. $8000–$12,000. Ill. C-4680.

Welding Engineer, mechanical or metallurgical graduate, to 45, to correlate design of metal objects to be fabricated by welding, specifying the materials and determining design of parts for welding and alloys to be used. Will be responsible to testing and inspection of weldments. $7200. Employer will negotiate fee. Ore C-4684.

Sales Engineer, Pumps, mechanical or metallurgical graduate, to 40, at least two years' experience in pump sales, service, application, or design. Will call on industrials, architects, engineers, and municipalities selling line of pumps and accessories. Must be able to estimate and figure costs from blueprint. To $9000. Employer will negotiate fee. Ohio or La. C-4685.

Production Engineer, mechanical or metallurgical, 30–45, at least five years' experience in pattern-shop and foundry procedure, design, and machine-shop operations. Will co-ordinate engineering, pattern-shop, foundry, and machine-shop operations for reducing costs. $9600–$12,000. Employer will negotiate fee. Ore. C-4686.

Senior Design Engineer, mechanical graduate, 28–40, five to ten years' experience in the design of small, fast-moving mechanisms, modern materials, and methods. Knowledge of communication-product design. Will design small, high-quality, low-cost mechanisms for consumer market. Oversee work of intermediate engineers and draftsmen. Work with personnel from other areas in development of these designs for production. Experience in government specifications. Some travel. $6800–$10,400. Employer will negotiate fee. Ill. C-4689.

Candidates for Membership and Transfer in ASME

THE application of each of the candidates listed below is to be voted on after April 25, 1956, provided no objection thereto is made before that date and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the Secretary of The American Society of Mechanical Engineers immediately.

New Applications and ●Transfers

California

CHAMBERLIN, LEONARD C., San Diego
KAHN, GEORGE S., Berkeley
LEE, CURTIS H., San Francisco
PERKINS, DOUGLAS S., Manhattan Beach
●SAWCHYN, STANLEY, Covina
SCHEEL, LYMAN F., San Gabriel
SIPPERLY, HAROLD P., Palo Alto

Colorado

YOST, ROGER H., Englewood

Connecticut

ATALLA, ANWAR A., Torrington
CONFORTI, MICHAEL D., JR., Torrington
DAVIS, ROGER M., Stratford
PULASKI, ALBERT A., Stratford
REED, HERBERT P., Stratford
SECCOMBE, LIONEL H., JR., Bristol

Delaware

BREUNINGER, FREDERICK C., Wilmington
HONNAKER, LELAND R., Wilmington
IRWIN, HOWARD D., Newark
KNODEL, CHARLES G., Wilmington
MARKWALDER, STANTON E., Newark

District of Columbia

SUDOL, JOHN M., Washington
SUNDARAM, JAMES, Washington
TATTON-BROWN, PETER D., Washington

Florida

TAMBINI, JAMES T., Melbourne

Georgia

GNANN, ARTHUR P., JR., Savannah

Illinois

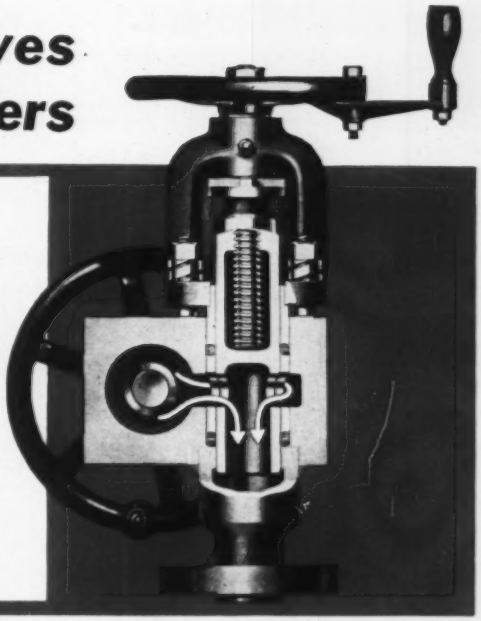
HANZEL, JOHN A., Paris
POSPHALA, RAYMOND A., Niles
RHODES, CARL L., Bloomington
STEVENS, CHARLES C., Lansing
TATTER, ERNEST O. P., Bensenville

●Transfer to Member or Affiliate.

(*ASME News continued on page 404*)

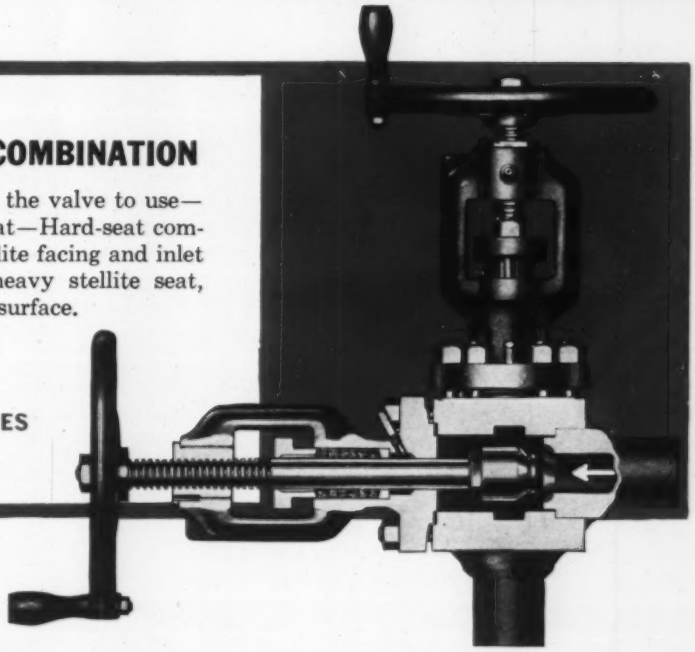
UNIT TANDEM

rugged blow-off valves for high pressure boilers



HARD-SEAT—SEATLESS COMBINATION

■ For boilers up to 1500 psi, this Yarway Unit Tandem Blow-Off Valve offers the maximum in dependable service. A one-piece forged steel block serves as the common body for the Yarway Stellite Hard-seat blowing valve and the Yarway Seatless sealing valve. All interconnecting flanges, bolts and gaskets are eliminated. The Unit Tandem at right is sectioned through Seatless Valve to show balanced sliding plunger in open position and free flow.



HARD-SEAT—HARD-SEAT COMBINATION

■ For boilers to 2500 psi, this is the valve to use—Yarway's Unit Tandem Hard-seat—Hard-seat combination. Disc has welded-in stellite facing and inlet nozzle has integral welded-in heavy stellite seat, providing smooth, hard-wearing surface.

OVER 4 OUT OF 5
HIGH PRESSURE PLANTS
USE YARWAY BLOW-OFF VALVES

Write for Yarway Catalog B-434

YARNALL-WARING COMPANY
108 Mermaid Ave., Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES

YARWAY BLOW-OFF VALVES

Indiana

ROGERS, JACK W., Fort Wayne
STEVENS, PORTER G., Whiting

Iowa

CHAPMAN, JESSE D., Ames
●PULLEY, FRANK L., Des Moines

Louisiana

COATES, JOHN J., Baton Rouge
LEAK, HARRISON C., JR., Baton Rouge
MCKINLEY, DEE C., Shreveport
MILES, GEORGE P., Shreveport
MORRIS, CARROLL N., Shreveport
TODD, THOMAS E., Arabi
WOODRUFF, CHARLES S., Baton Rouge

Maryland

●ELLIOTT, R. EARL, Severna Park
HOWELL, ROBERT L., Baltimore
●REZNEK, BEN, Silver Spring

Massachusetts

●ASTILL, KENNETH N., Medford
MILO, JOHN F., Swampscott
PECK, ROBERT D., Boston
TERPE, GUNTER R., Worcester

Michigan

KOWALSKI, ARTHUR R., Detroit
LIPPERT, CHARLES G., Detroit
MORENZ, EDWIN E., Detroit
●MYRON, PAUL, Detroit

Minnesota

WEITZEL, RAYMOND J., Minneapolis

Missouri

HURST, GLADE W., St. Joseph
JANSEN, JAN, Kansas City

New Jersey

HEATLEY, WILLIAM A., JR., Paterson
KENNEDY, PETER J., Sea Girt
MECKLEM, WILLIAM M., Burlington
NEEF, ADOLPH J., Bergenfield
RYAN, FRANCIS J., Harrison
SCERBO, CONSTANTINE W., Jersey City
SCHELLER, JOHN A., Florham Park
SHERMAN, JAMES L., Woodstown
WILKS, JOHN T., Cliffside Park

New Mexico

WILSON, CHARLES E., JR., Holloman AFB

New York

BRUGGEMAN, WARREN H., Watervliet
CORVEN, ANDRE, New York
ESTABROOK, LOUIS H., Schenectady
EWERT, ALBERT C., JR., Mt. Vernon
FAZEKAS, GABRIEL A. G., Floral Park
GERNER, WILLIAM J., Lockport
HEMMER, GEORGE A., Poughkeepsie
HURLEY, JOSEPH W., Beaver Dams
●KIRCHMAYER, LEON K., Scotia
KNOWLES, DANIEL H., Painted Post
KONDRA, EMIL P., New York
KUHN, MILTON F., Kenmore
LANE, THOMAS L., Brooklyn
●LIND, JULIUS A., Kenmore
MARION, ROGER E., New York
●MCADAM, LON J., 2ND, Barker
PARKER, THERON D., New York
PHEREOZE, NADIR N., New York
SIRECI, ANTHONY R., Jamaica
STANKIEWICZ, CHESTER H., Staten Island

Ohio

FANOS, NICHOLAS G., Cincinnati
HAMRICK, JOSEPH T., Cleveland
IMBRIE, WILLIAM, Glendale
MCCOMB, HENRY E., Chillicothe
OROSZ, ALBERT A., Parma
PAESE, JOSEPH M., Columbus
REED, WILLIAM B., Lakewood
SCARBOROUGH, WALTER G., Cleveland
URQUHART, JOHN A., Cleveland
VON HOENE, HARRY L., Cincinnati

Oregon

OVERALL, EDWARD R., Portland
WRIGHT, CARROLL S., Portland

Pennsylvania

ANTHONY, WILLIAM T., Bethlehem
BLOOMQUIST, WALTER C., Philadelphia
●DEVINE, JOHN E., New Kensington
GADDIS, PAUL O., Library
KERSHNER, CHARLES L., Swarthmore
PRICE, JAMES L., Pittsburgh
SPURLOCK, CHARLES H., East Pittsburgh
●TORMEY, JOHN E., JR., Erie

Rhode Island

BELANGER, ALVIN P., Bristol Ferry
FRIEDLAND, NORMAN, Providence

South Carolina

CLARE, FOUNTAIN S., Columbia
●SCHANES, ALAN, Camden

Tennessee

HOSKINS, LOUIS P., Kingsport
●VOORHIES, EDWIN S., Murfreesboro

Texas

BRIDGES, JOHN S., JR., Lake Jackson
BRUNS, JOSEPH L., Austin
DAY, FRANK A., Dallas
GEORGE, LOUIS, Hondo
LAFOSSE, PERCY L., Baytown
PIERCE, PHILLIP E., Dallas
PRUDHOMME, ROBERT J., Dallas

Virginia

EDWARDS, JOHN C., Roanoke
KATZ, SILAS, Arlington

Washington

MCALISTER, ROY E., Spokane
NIESSE, DONALD H., Seattle
●RICHARDS, WILLIAM A., Richland
SMOOTS, WILLIAM F., Spokane
WEIKS, JOHN E., SR., Seattle

Wisconsin

ESTY, F. BURROWS, Milwaukee

Foreign

BANERJIE, ANIL K., W. Bengal, India
COURTNEY, JESSE B., Anchorage, Alaska
RASHID, CH. ABDUL, Lahore, W. Pakistan
SIDDIQI, ZAKI A., Gorakhpur City, U. P., India
STEVENS, WESTON R., St. Lucie, Que., Can.
UREN, WILLIAM S., Cornwall, England
ZAKRZEWSKI, ROMAN Z., Toronto, Ont., Can.

Transfers from Student Member to Associate Member 74

Obituaries

James Ralph Blackshear (1926–1954), engineer, W. S. Kilpatrick & Co., Los Angeles, Calif., died Dec. 24, 1954. Born, Honolulu, T. H., Jan. 1, 1926. Parents, Kemp H. and Mina M. Blackshear. Education, BS(ME), University of California, 1950. Assoc. Mem. ASME, 1950.

George Wills Borton (1870–1955?), whose death was recently reported to the Society, was, until his retirement, president and general manager, Pennsylvania Crusher Co., now a division of Bath Iron Works Corp. Born, Rancocas, N. J., Nov. 6, 1870. Parents, George B. and Sarah W. Borton. Education, graduate, Westtown School; attended Sibley College, Cornell University. Married Elizabeth A. Lippincott; daughter, Gertrude. He held more than 25 patents on crushing machinery. Mem. ASME, 1921.

Walter Edward Casey, Jr. (1924–1955), engineer, Harris-Seybold Co., Cleveland, Ohio, died May 11, 1955. Born, Boston, Mass., June 23, 1924. Parents, Mr. and Mrs. Walter E. Casey. Education, BS in Business and Engineering Administration, Massachusetts Institute of Technology, 1951. Jun. Mem. ASME, 1951. Survived by wife, Barbara, and two daughters, Mary Ann and Patricia.

Ralph Shepard Damon (1897–1956), president, Trans World Airlines, New York, N. Y., since 1949, died Jan. 4, 1956. Born, Franklin, N. H., July 6, 1897. Parents, William C. and Effie (Ives) Damon. Education, AB, cum laude, Harvard University, 1918; hon. DE, Clarkson College of Technology, 1941. Married Harriet Dudley Holcombe, 1922. Mem. ASME, 1941. Recipient of the 1955 ASME Spirit of St. Louis Medal "for meritorious service in the field of aeronautics." He had been associated with aeronautics since 1922. He joined the Curtiss Aeroplane and Motor Co. in 1922, was factory superintendent at the age of 25, and became president in 1935. He was instrumental in the development of such planes as the Curtiss Robin, the Thrush, and the Condor, the first all-sleeper transport. In 1936 he took a position as vice-president of operations for American Airlines. During World War II the Government persuaded him to become president of the Republic Aviation Corp., an important supplier of fighter planes. He put the famous P-47 Thunderbolt into mass production. He returned to American in 1943 and was elected president in 1945. He was member, by Presidential appointment, of the National Advisory Committee for Aeronautics and of several other technical organizations. Survived by wife; four children, Mrs. H. M. Rainie, Jr., Garden City, N. Y., Mrs. Barbara Bessinger, London, England, Dr. William A., Providence, R. I., and Edmund H., Montreal, Que., Can.; two grandchildren; and two sisters, Mrs. S. W. Kletzien, Swarthmore, Pa., and Mrs. Stuart Bugbee, Wilmington, Del.

William E. S. Dyer (1880–1955), proprietor of firm of consulting and designing engineers bearing his name, Buffalo, N. Y., died Dec. 8, 1955. Parents, Paris P. and Florence A. Dyer. Education, private tutors in engineering, architecture, and law of contracts. Married Bertha F. Faber; children, William E. S., Jr., and Elizabeth S. Mem. ASME, 1927. He was long identified with the development of pulverized-coal and fuel-oil-firing methods and boiler design and operation. Conducted wide research in United States and Europe on high-pressure and high-temperature steam. Author of numerous articles on power-plant design and operation.

Walter William Engelking (1893–1955), chief engineer, Superior-Lidgerwood-Mundy Corp., Superior, Wis., died Dec. 8, 1955. Born, Waterloo, Iowa, Sept. 16, 1893. Parents, John H. and Geselia (Diercks) Engelking. Education, high-school graduate; completed mechanical-engineering course, International Correspondence School. Married Lulu B. Price, 1913. Married 2nd, Geraldine Lundeen, 1946; children, Gerald D. (adopted) and Walter W. Jun. ASME, 1920; Assoc. Mem. ASME, 1921; Mem. ASME, 1935.

George Jacob Kuhrts (1895–1955), self-employed designer of fish canneries, fertilizer and chemical plants, food-processing equipment, and the like, Los Angeles, Calif., died Nov. 21, 1955. Born, Los Angeles, Calif., June 27, 1895. Education, graduate, Polytechnic High School; attended University of Southern California, 1915–1917. Held several patents pertaining to portable paving plants. Mem. ASME, 1949.

Fred Herboth Podmore (1896–1955), manager, construction and maintenance department, Richfield Oil Corp., Los Angeles, Calif., died Nov. 6, 1955. Born, St. Louis, Mo., April 2, 1896. Education, high-school graduate; special tutoring and college courses in engineering; International Correspondence School courses. Mem. ASME, 1937.

Philip Royal Pullen (1922–1955), chief engineer, Dealers Supply Co., Rapid City, S. Dak., died in July, 1955. Born, Lead, S. Dak., May 18, 1922. Education, BME, Cornell University, 1948. Assoc. Mem. ASME, 1948.

Bernhardt Frederick Reimers (1897–1955), consulting engineer, New York, N. Y., died July 28, 1955. Born, New York, N. Y., Aug. 6, 1897. Parents, Bernhardt N. and Marie Reimers. Education, 4 years, Rensselaer Polytechnic Institute. Author of several technical papers published in trade journals. Jun. ASME, 1925; Mem. ASME, 1931.

Edwin Burnley Ricketts (1883–1956), retired mechanical engineer, Consolidated Edison Co. of New York, Inc., and consulting engineer, New York, N. Y., died Jan. 8, 1956. Born, Brookhaven, Miss., Aug. 8, 1883. Parents, Robert S. and Bertha (Burnley) Ricketts. Education, BS, Millsaps College, 1901. Married Annie Lee Moore, 1907. As mechanical engineer of Consolidated Edison, he was in charge of plant mechanical design. In the 1920's he was instrumental in the mechanical designing of the utility's Hell Gate and East River electric-generating stations. Jun. Mem. ASME, 1908; Mem. ASME, 1916; Fellow ASME, 1948. He served the Society as vice-president in 1941; as chairman of the Committee on Code for Pressure Piping; and as a member of various other committees, including the Special Research Committee on Boiler Furnace Refractories. He represented ASME on the Pure Air Committee of

(*ASME News continued on page 406*)

NEW!

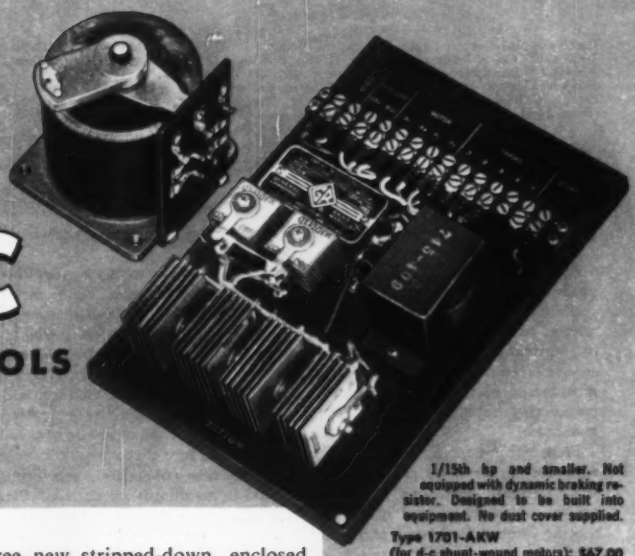
Stripped-Down, Low-Priced

Variac®

MOTOR SPEED CONTROLS

for 1/6, 1/3 and 3/4 hp

D-C Motors on A-C Lines



1/15th hp and smaller. Not equipped with dynamic braking resistor. Designed to be built into equipment. No dust cover supplied.

Type 1701-AKW
(for d-c shunt-wound motors): **$67.00**

Type 1701-AUW
(for series or universal motors): **$67.00**

The addition of three new stripped-down, enclosed models now makes the G-R line of these popular controls available in seven simplified units for controlling d-c motors from 1/15th hp to 1½ hp.

VARIAC® Motor Speed Controls Feature:

★ Extreme Simplicity ★ Exceptionally Long Life ★ Essentially Maintenance-Free Operation ★ Easy Installation ★ Very Low Torque Pulsation ★ Heavy Overload Capacity for Fast and Repeated Starting ★ Dynamic Braking for Extra Fast Stopping and Reversing ★ Smoothly Controlled Torque for Delicate Starting Operations ★ Selenium Rectifiers — No Electron Tubes — No Warm-Up Time — Controls Operate Instantly When Power is Applied ★ ANY Speed Desired — Multi-Step Pulleys and Gears no Longer Needed

User supplies switching for all the stripped-down models, and overload protection in addition on models through ¾ hp. The 1 and 1½ hp stripped down controls have thermal overload relays in the VARIAC case. Models under 1/6 hp rating do not include braking resistor.

Switching is easily provided for all requirements. Among the simple arrangements are:

★ Appliance-type switch with contacts to break a-c and d-c circuits simultaneously and also handle reversing and dynamic braking. ★ Drum-controller type for heavy-duty machine shop operation. ★ DPDT toggle switch, where reversing is never required, for starting and stopping with dynamic braking. ★ Limit switch of the manual-resetting, snap-action type to stop a machine at a predetermined point. Switch will stay in "Off" position while machine is being set up; reset button used for re-starting.

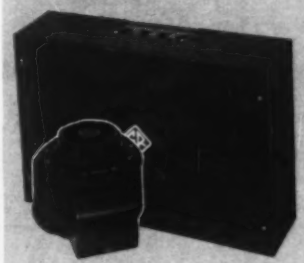
All of the VARIAC Motor Speed Controls illustrated are available in complete models. Complete models are identical with the stripped-down units with the addition of an A-B Drum-Type Controller. Smaller models have the switching mounted directly on the panels, and are equipped with panel-mounted overload protection.

Accompanying prices are for 1 to 4 identical controls. Substantial discounts apply for larger quantities.

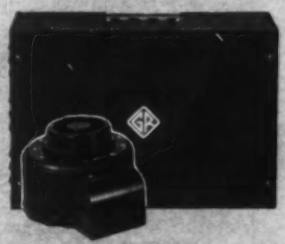
1/6th hp. Completely enclosed, with dynamic braking. **Type 1703-BW: $97.50**

1/3 hp. Completely enclosed, with dynamic braking. **Type 1700-CW: $145.00**

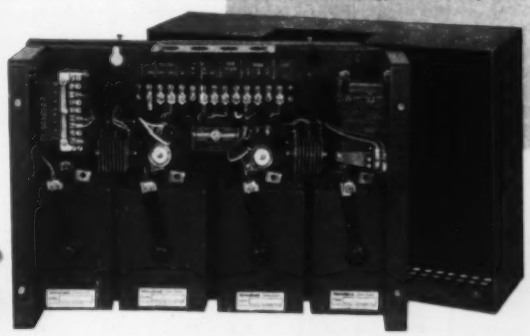
¾ hp. Completely enclosed, with dynamic braking. **Type 1702-BW: $205.00**



1 hp. Completely enclosed, with dynamic braking. Overload breaker mounted in VARIAC control. **Type 1704-BW: $308.00**



1½ hp. Completely enclosed, with dynamic braking. Overload breaker mounted in VARIAC control. **Type 1705-BW: $338.00**



Inside of Types 1704-BW and 1705-BW showing convenient wall mounting slots, ventilated dust cover and plainly marked wiring terminals. Dust cover readily removed for occasional maintenance.

Write for the NEW MOTOR CONTROL BULLETIN

GENERAL RADIO Company

275 Massachusetts Avenue, Cambridge 39, Massachusetts

90 West Street **NEW YORK 6** — 8055 13th St., Silver Spring, Md. **WASHINGTON, D. C.**

1150 York Road, Abington, Pa. **PHILADELPHIA**

920 S. Michigan Ave. **CHICAGO 5** — 1000 N. Seward St. **LOS ANGELES 38**

the National Electric Light Association in 1931–1932 and was a former chairman of the Prime Movers Committee of the association and the Edison Electric Institute. Survived by a son, Dr. E. T. Ricketts of Panama; a daughter, Mrs. Orrin Hall, Bayville, L. I.; a brother, John B. Ricketts, Greenville, S. C.; a sister, Mrs. Bertha R. Sumner, Duxbury, Mass.; and three grandchildren.

John D. Riggs (1857–1953?), whose death was recently reported to the Society, was a design engineer of Indianapolis, Ind. Born, Chariton, Iowa, Oct. 29, 1857. Parents, H. and Anna J. (Middleton) Riggs. Education, one year Kansas State University; three years, Ohio State University. Married Ellen McCuen, 1896. He specialized in the design of special machinery, tools, and dies for sheet-metal goods in quantity. Author of numerous papers published in technical journals. Jun. ASME, 1892.

Edward Leggett Sherwood (1885–1955), president and chief engineer, E. L. Sherwood Co., New York, N. Y., died Dec. 3, 1955. Born, Brooklyn, N. Y., Aug. 2, 1885. Parents, James C. H. and Mary (Leggett) Sherwood. Education, two years, Highland Park College, Des Moines, Iowa. Married Edith Grace Perkins, 1907. Assoc. Mem. ASME, 1920; Mem. ASME, 1935. Survived by wife and daughter, Mrs. Louise Ross, New York, N. Y.

Charles Boerner Skinner, Jr. (1923–1955), mechanical engineer and manufacturing representative, W. H. Grant, Jr., New Orleans, La., died Aug. 15, 1955. Born, New Orleans, La., July 27, 1923. Education, BE(ME), Tulane University of Louisiana. Jun. ASME, 1948.

Tilden Ward Southack (1911–1955), aeronautical engineer engaged in experimental work on wing structures, Greenwich, Conn., died in April, 1955. Born, Montclair, N. J., Feb. 6, 1911. Parents, Bogart G. and Josephine (Ward) Southack. Education, BS, Yale University, 1933. Married Jeanne Warren, 1933; son, Bogart R. Jun. ASME, 1933.

Charles Bernard Spiess, Jr., (1921–1955?), whose death was recently reported to the Society, was assistant plant engineer, American Snuff Co., Clarksville, Tenn. Born, Clarksville, Tenn., Aug. 20, 1921. Education, BSME, Alabama Polytechnic Institute, 1947. Jun. ASME, 1947; Mem. ASME, 1952. Designed an all-steel, ball bearing, hogshead turntable for distributing tobacco to five hogsheads from an overhead chute; a 1000-psi hydraulic tobacco press; and a sack roller and hydraulic lift for flattening and stacking 130-lb filled snuff sacks.

Charles Henry Stanbridge (1893–1955), consulting engineer, Port Elizabeth, South Africa, died Dec. 12, 1955. Born, Uitenhage, Eastern Province, South Africa, Aug. 31, 1893. Education, Second Class Cape Matriculation (first class in mathematics, second class physics). Studied advanced electricity and physics at Rhodes University, Grahamstown. Postgraduate courses in mechanical engineering, King's College, University of London, England, 1921–1924. Served in both world wars; in the second, as a Major, SAREC, Union Defense Forces, he was in charge of construction of coastal batteries, airports, air stations, and whaling factories. He also was confidential adviser to the Secretary of Defense, Union Defense Forces, Pretoria, in connection with Engineering War Contracts. Author of several technical papers, including the thesis, "Land and Marine-Type Diesel Engines." Mem. ASME, 1953. He also held membership in British and South African technical societies.

Thomas Rouse Tate (1888–1955), consulting engineer, Chas. T. Main, Inc., Boston, Mass., died Feb. 9, 1955. Born, Eldorado Springs, Mo., June 4, 1888. Parents, Thomas W. and Anna Simms (Rouse) Tate. Education, BS(EE), School of Engineering, University of Missouri, 1912. Married Agnes Leona Bramblett, 1912; children, Mrs. Jean E. T. Torgerson, Thomas R., Jr., David B., and Robert B. Mem. ASME, 1926. Author of several papers presented before professional societies.

Richard Hale Toth (1931–1955), junior engineer, Douglas Aircraft Co., Inc., Santa Monica, Calif., died Sept. 12, 1955. Born, Pittsburgh, Pa., Feb. 18, 1931. Education, BS(ME), University of California, 1953. Jun. ASME, 1953.

Peter C. Van Gilst (1880–1955), vice-president, charge of operations, Kentucky-West Virginia Gas Co., Ashland, Ky., died Dec. 3, 1955. Born, Rotterdam, The Netherlands, Oct. 31, 1880. Education, BME, Iowa State College, 1908. Mem. ASME, 1949.

Henry Herman Yerk (1892–1955), Eastern sales manager, The Niles Tool Works Co., Hamilton Division, Baldwin-Lima-Hamilton Corp., New York, N. Y., died Dec. 24, 1955. Born, Chicago, Ill., Feb. 1, 1892. Parents, John A. and Helena (Heiden) Yerk. Education, high-school graduate; ICS mechanical-engineering course. Married Ellen Granberg, 1911. Held 15 patents pertaining to microgrinders, oil-burners, and bread slicers. Mem. ASME, 1944. Survived by wife and a daughter, Mrs. Ruth Y. Edminson, Fort Wayne, Ind.

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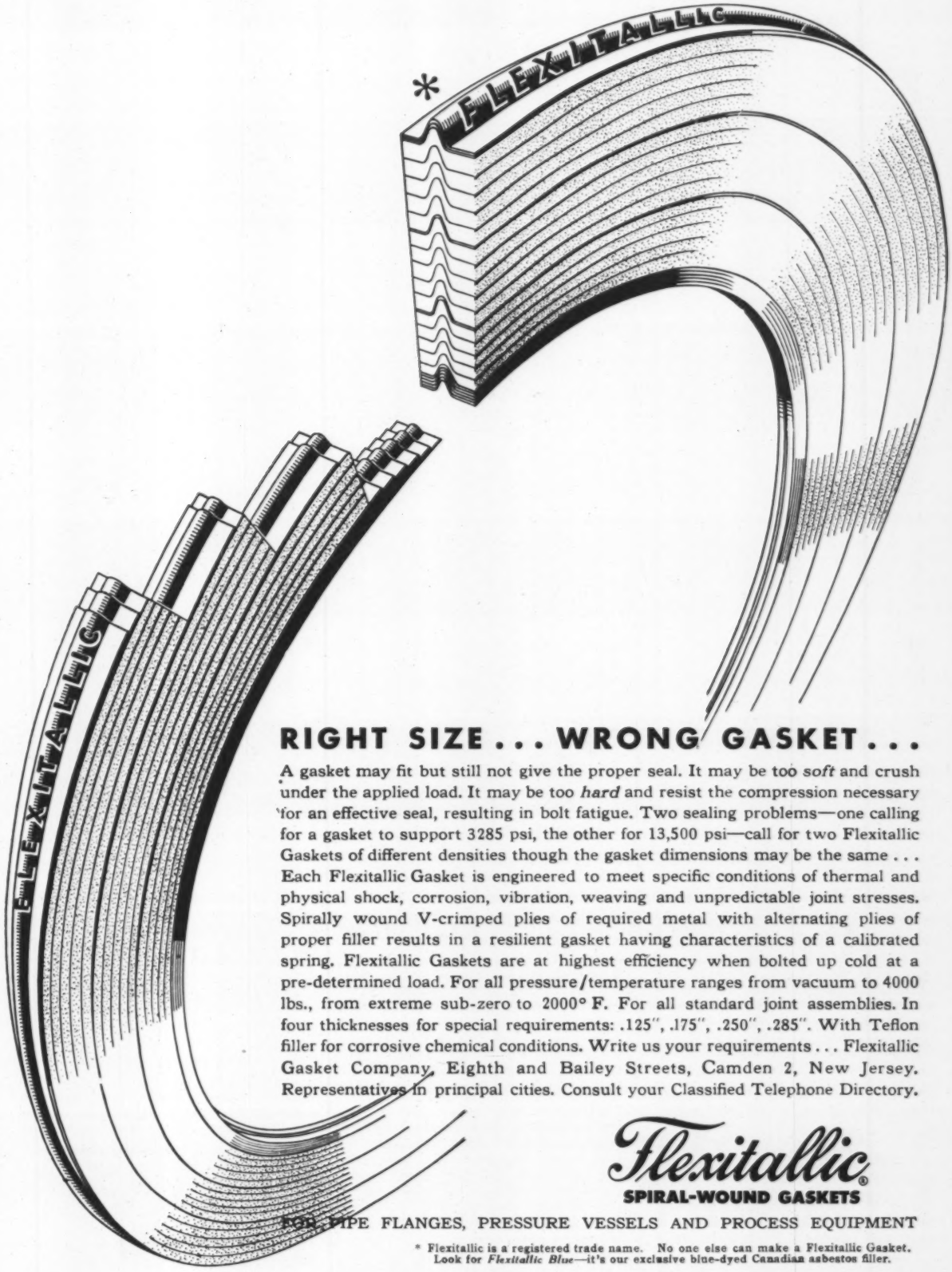

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B	2	Fig. 295 Br. Sw. Check	Prevent backflow thru well pumps
C	1	Fig. 677A Br. Gate	Warm water well shutoff valve
D	6	Fig. 368 Br. Gate	Circ. pump shutoff valves
E	1	Fig. 106A Br. Globe	Settling Tank drain valve
F	1	Fig. 368 Br. Gate	Shutoff discharge to warm water well
G	1	Fig. 368 Br. Gate	Control water to evaporator
H	1	Fig. 368 Br. Gate	Control water to condenser
J	1	Fig. 368 Br. Gate	Control water to warm water well
K	1	Fig. 368 Br. Gate	Control water to ch. water pump
L	1	Fig. 106A Br. Globe	Constant head regulator bypass
M	2	Fig. 368 Br. Gate	Constant head regulator shutoff
N	2	Fig. 352 Br. Sw. Ch.	Prevent backflow thru circ. pumps
P	2	Fig. 368 Br. Gate	Ch. water temp. regulator shutoff
R	1	Fig. 106A Br. Globe	Ch. water temp. regulator bypass
S	2	Fig. 368 Br. Gate	Evaporator shutoff
T	1	Fig. 352 Br. Sw. Check	Prevent backflow thru evaporator
U	1	Fig. 368 Br. Gate	Shutoff water to recovery & precon coil
V	1	Fig. 368 Br. Gate	Shutoff discharge to cold water well
W	1	Fig. 368 Br. Gate	Control water to hot water pump
X	1	Fig. 368 Br. Gate	Shutoff water to heating coil
Y	1	Fig. 368 Br. Gate	Control water to hot water pump
Z	1	Fig. 368 Br. Gate	Control water to ch. water pump
AA	1	Fig. 368 Br. Gate	Control water to warm water well
BB	2	Fig. 368 Br. Gate	Condenser shutoff
CC	1	Fig. 47 Br. Gate	Expansion tank shutoff valve
DD	1	Fig. 47 Br. Gate	Expansion tank shutoff valve
EE	1	Fig. 47 Br. Gate	Control makeup to expansion tank
FF	1	Fig. 92 Br. Sw. Check	Prevent backflow to water lines
GG	5	Fig. 106A Br. Globe	Drain valves

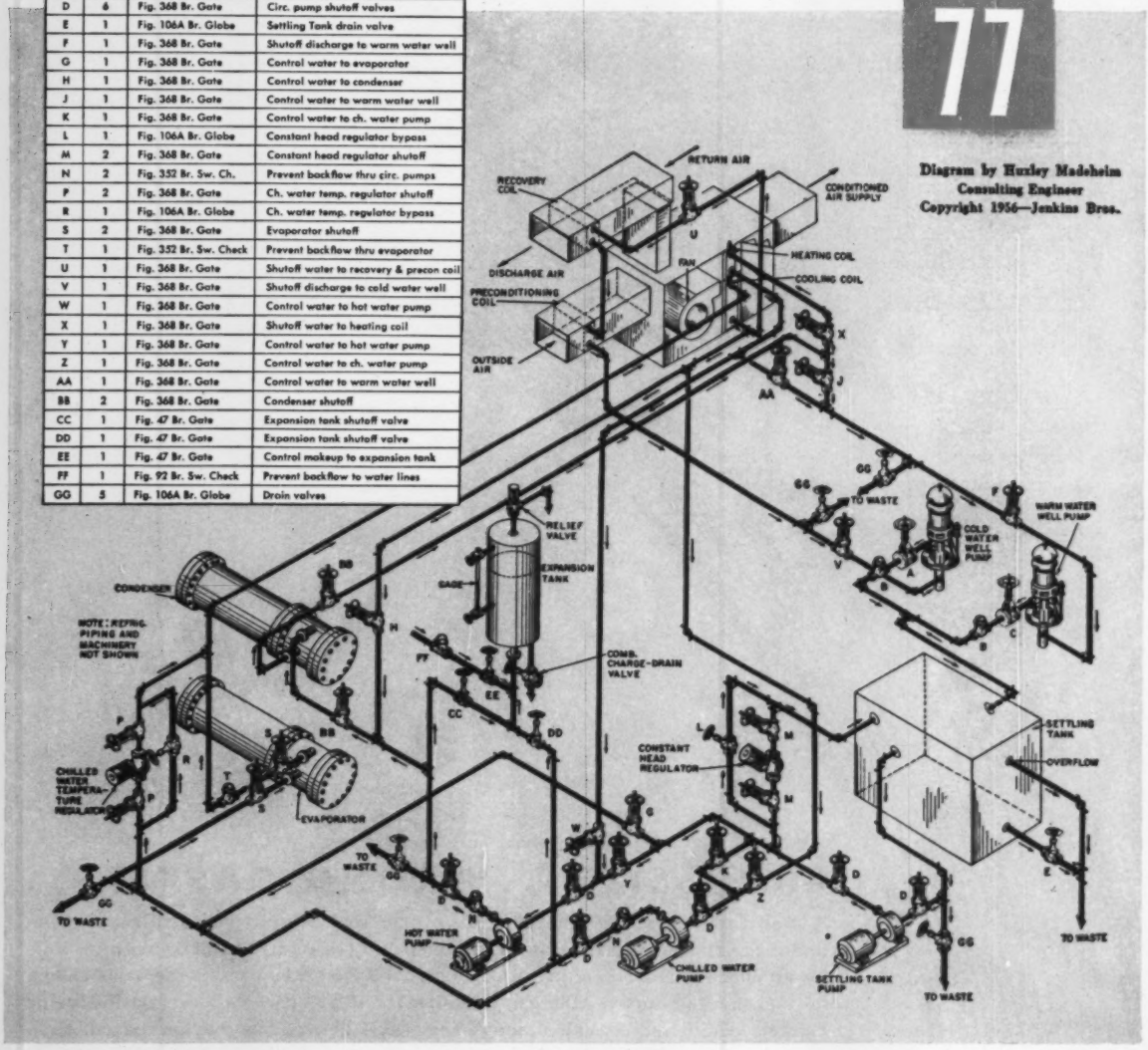

Diagram by Huxley Madeheim
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How to plan piping connections for all-year

AIR CONDITIONING WITH THE HEAT PUMP

Well water is used in the basic heat pump installation illustrated. Such a system could readily serve a building with several exterior and interior zones, which would have many air handling units. For simplicity, only one unit is shown in the diagram.

For heating demands, this system provides a closed circuit consisting of hot water pump, condenser, and heating coil. For cooling, a second closed circuit consists of chilled water pump, evaporator, and cooling coil.

During the heating season, water is supplied to the settling tank from the warm water well (about 60° F). It is circulated by the chilled water pump to the evaporator, and then to the cooling coil to provide cooling, where needed, for interior areas. The water then flows to the recovery coil, picks up heat from waste air and carries it to preconditioning coil, where it is used to preheat outside air. The resulting chilled water is discharged to the cold water well.

During the intermediate seasons, water is supplied to the settling tank from the cold water well (about 50° F). It is circulated by the hot water pump to the condenser, and then to the heating coil to provide heat, where needed, for the exterior zones. The water is then discharged to the hot water well.

During the cooling season, water from the cold water well is pumped to the settling tank, and then circulated to the evaporator and the cooling coils. It is next used to cool the condenser, and is then discharged to the hot water well. If the demand for cooling is low, and the well water cold enough, the evaporator may be bypassed.

Consultation with accredited piping engineers and contractors is recommended when planning major piping installations.

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1 SEAMLESS PIPE

Babcock & Wilcox Co., Tubular Products Div.—A 46-page pocket-sized manual covers the methods of working seamless tubes and pipe made of the firm's intermediate Croloys. Sections in the booklet include nominal composition, general characteristics, annealing practice, methods of working, welding and condensed technical data.

2 MOTOR DRIVEN INTERRUPTER

National Pneumatic Co., Holtzer-Cabot Div.—Bulletin CTE-6 illustrates and describes 25-BC motor driven interrupter with nylon cams and followers. The unit, available for automatic control or similar applications, can be obtained in two models, containing from 1 to 6 circuits or from 7 to 18 circuits.

3 VARIABLE PUMPS

Racine Hydraulics & Machinery Co.—Bulletin P-10-F illustrates and describes variable pumps in capacities from 5 to 70 gpm. Also included are specifications of sleeve type hydraulic valves and controls and pressure boosters to 5000 psi.

4 WORM GEAR JACK

Duff-Norton Co.—An 8-page manual illustrates applications of the company's worm gear jack for raising and lowering movable parts in metal-working machinery. Included are the elevation of mill tables, rolls, conveyors, machine beds.

5 CUSTOM PRODUCTS

Vard, Inc.—Bulletin No. 1003 illustrates and describes such custom products as rotary and linear actuators, ballscrew mechanisms, gear assemblies, landing gear actuators, flap actuating systems, ball spline mechanisms, non-ferrous castings, shell molding, tab actuators, hydraulic components.

6 SILICONE PRODUCTS

Garlock Packing Co.—An eight-page bulletin covers silicone products for use in diaphragms, gasketing, sheet packing, oil seals, rings, insulation tape, rod and valve stem packings, and for molded, extruded, die-cut and metal-bonded shapes for various uses. Silicone sponge applications are included.

7 INSPECTION INSTRUMENTS

Kollmorgen Optical Corp.—Literature describes Zeiss-Kollmorgen borescopes, instruments for visual close-up inspection and examination of such internal areas as tube walls, rifle bores, small arms, injectors, gas cylinders, tanks, piping, engine cylinders, boiler tubes, oilfield equipment, pressure vessels, aircraft structures.

8 BELT CONVEYOR CARRIER

Stephens-Adamson Mfg. Co.—Belt conveyor carrier bulletin covers the company's line of standard units. New addition to the line is a long center roll carrier with either 35 to 45 deg slope end rolls for greater carrying capacity on light materials. The bulletin describes a number of special carrier units, as well as belt conveyor trippers and accessories.

9 BEARING BRONZE

Bearium Metals Corp.—Three-color, 6-page folder describes the frictional properties available in Bearium Metal and illustrates typical bar stock sizes and individual castings. Photomicrographs show structure and lead distribution achieved in production of this metal, accounting for its advantages for bearings, bushings, thrust washers, and other requirements involving rubbing friction.

10 VERTICAL PUMPS

Food Machinery & Chemical Corp., Peerless Pump Div.—Bulletin No. B-1700 describes and illustrates with technical descriptions the design and construction of two types of "can type" pumps for application to petroleum refinery techniques, line booster service, condensate service and chemical processing service. A process type and a transfer type are available with a capacity range of up to 3000 gpm and head range of up to 1000 ft and a temperature range of up to 400 F.

11 AUTOMATIC BOILERS

Orr & Sembower, Inc.—Bulletin 1220 covers Powermaster packaged automatic boilers for light oil, heavy oil, gas or combination gas-oil

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YOUR *New Catalogs* GUIDE

firing in sizes to 500 hp, pressures to 250 psi. The units are completely factory assembled, and have fully automatic operating and safety controls.

12 INDUSTRIAL RADIOGRAPHY

Metal & Thermit Corp.—A four-page folder illustrates and describes Kel-Ray projectors for industrial radiography with gamma rays. The units are portable. Encapsulated cobalt 60, cesium 137, iridium 192 are used as the sources for gamma rays.

13 SAFETY, RELIEF VALVES

Kunkle Valve Co.—A 50-page catalog, No. 53, has selection indexes for steam, air-gas, and liquid ASME Std spring loaded safety valves for pressures to 5000 lb in brass, bronze, iron, and steel. Included are descriptions, dimensions, certified relieving capacities, and applications.

14 VIBRATION MOUNTS

Lord Mfg. Co.—Bulletin 700 describes temproof mountings for vibration isolation on base-mounted equipment where vibratory disturbances are 15 cps or higher and where operating temperatures range from −80 to −250 F. Graphs show performance data; diagrams illustrate the mountings.

15 ALUMINUM ALLOYS

Kaiser Aluminum—A 24-page booklet offers information on mill products and services. Data is given on aluminum alloys, forms, mechanical and physical properties, applications, fabricating and finishing techniques and availability. Products include sheet, plate, foil, circles, pig, alloy ingot, rod, bar, wire, electrical conductors, forgings, extrusions, extrusion billets, roofing, siding, shade screening.

16 FITTINGS, TUBING

U. S. Hoffman Machinery Corp.—A four-page bulletin, No. SF-155, entitled, "Smooth-Flow Fittings and Tubing," illustrates various sizes and shapes of new standard steel and zinc-impregnated fittings and tubing. The bulletin also contains information and diagrams on the slip joint and clamp assembly with quick dismounting features.

17 FLEXIBLE SEAL

New Departure Div., General Motors Corp.—A folder illustrates and describes the sentriseal, a new type of flexible seal available on a large variety of standard dimension ball bearings. This seal, which is also available on a series of adapter bearings makes it possible to relubricate where desired, without removing the seals. Seals are easily removed if required.

18 STEEL TUBULAR HEATERS

Mammoth Furnace Co.—Literature describes direct-fired space heaters in capacities from 300,000 to 2,000,000 Btu for commercial and industrial space heating requirements, and oil, gas, stoker and hand-fired vertical steel tubular heaters in capacities from 175,000 to 2,379,000 Btu for churches, schools, factories, auditoriums, commercial buildings.

19 UTILITY BLOWERS

Peerless Electric Co.—Bulletin SDA-200 illustrates and describes the firm's non-overloading belt drive utility blowers. Dimensional data is tabled and diagrammed and engineering information and specifications are included for 12 sizes of blowers.

20 VALVES

Ledeen Mfg. Co.—A 16-page bulletin illustrates and describes the company's line of hand, foot, power and solenoid operated valves, air, oil, gas or water powered. Bulletin gives operating and flow cycles, dimensions and weights. Circuit diagrams, parts and accessories are included.

21 CENTRIFUGAL PUMPS

Goulds Pumps, Inc.—Two bulletins cover pumping applications in industry. Bulletin 721.6 shows 19 sizes single stage double suction centrifugal pumps for capacities up to 6400 gpm, heads up to 400 ft. Bulletin 722.6 shows 5 sizes two-stage centrifugal pumps, capacities up to 1200 gpm, heads up to 1000 ft. Maximum of standardization and interchangeability of parts are described.

YOUR

New Catalogs GUIDE

22 SPEED REDUCERS

Farrel-Birmingham Co.—A 52-page bulletin, No. 450, contains information on the firm's re-engineered, repeated, and expanded line of speed reducers. Included are horsepower rating tables, specifications, dimensions, weights and other selection and application data.

23 NEW METHOD OF LUBRICATION

Stewart-Warner Corp., Alemite Div.—Catalog describes new method of lubricating industrial machinery with "Oil-Mist." Bulk of publication taken up with engineering data, covering applications, operation, bearing application, bearing speeds of this method. Also for plain bearings, selection of condensing fittings, intermixing of condensers, bearing grooving and many other engineering data appropriate to the subject.

24 COUPLINGS

Snap-Tite, Inc.—Four bulletins and various data sheets cover couplings for high pressure systems, gravity flow systems, vacuum systems and hydraulic systems. Cutaway photos, diagrams and flow charts are included in the literature.

25 HYDRAMOTOR VALVES

General Controls Co.—A 50-page catalog describes the firm's newly expanded line of Hydramotor valves (motor-operated) for remote control of all industrial liquids and gases, shutoff, three-way, and proportioning control. Engineering data section for use in selection and application, flow characteristics, charts and tables are included.

26 TURBINE SEAL

Koppers Co., Inc.—Huhn carbon rings for steam turbine applications are illustrated and described. A discussion of labyrinth, carbon garter spring ring and carbon ring sealing devices is included in this four-page folder.

27 ALUMINUM

Revere Copper & Brass, Inc.—"Revere Aluminum Products" 36 pages, discusses the advantages of aluminum alloys, the variety of extruded products available, the uses to which seamless drawn tube and pipe can be put, and the uses of sheet, bus bar, and die-pressed forgings. It contains many tables giving both mechanical and physical properties.

28 CUSTOM BUILT CYLINDERS

Oilgear Co.—Bulletin 79,000 covers design and materials for custom cylinders using 1500 psi, 3500 psi or higher pressures and strokes from $2^{3}/_{4}$ in. to 18 ft. These heavy-duty cylinders have been applied to wind tunnel operation, steel mill charging and stripping equipment, landing gear drop testing, rail welders, presses and other applications. It includes cylinders for pushing or pulling, fine feed or high speed, static of dynamic loads, slow or fast reciprocation, differential or nondifferential systems, and combinations of these and other requirements.

29 BRONZE SLEEVE BEARINGS

Bunting Brass & Bronze Co.—Standard stock industrial cast bronze sleeve bearings, bronze bars, electric-motor cast bronze sleeve bearings, and graphited oilless sleeve bearings are contained in Catalog 52. There are 854 different sizes of standard stock bearings, from $^{3}/_{16}$ in. to $4^{1}/_{2}$ in. ID, and 324 different electric motor bearings, as well as 263 sizes of tubular and solid bars.

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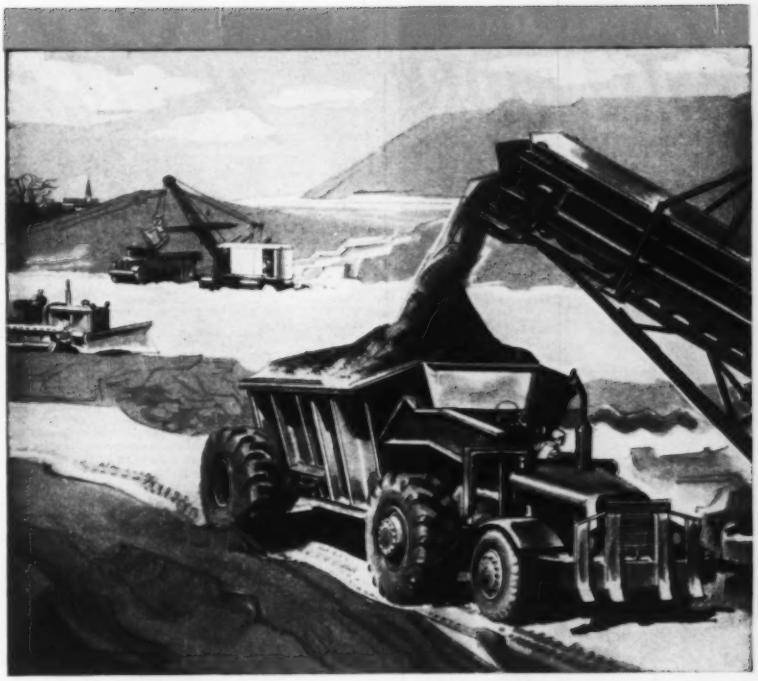

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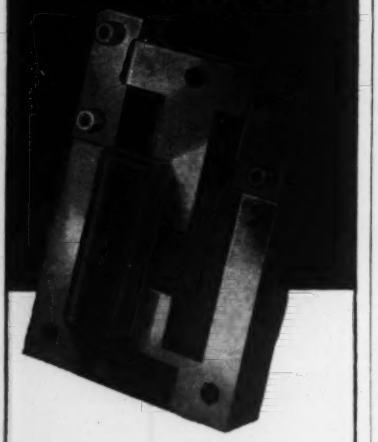

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LATEST INDUSTRIAL LITERATURE

30 AIR, OIL, WATER VALVES

Barksdale Valves—Shear-Seal valves are listed by major service condition—air, oil, water—in three bulletins. A-5 covers manually and foot operated air valves, 0 to 4000 psi; W-5, manual water valves, 0 to 6000 psi; 0.5, manual oil valves, 0 to 6000 psi. Bulletins include valve characteristics, flow patterns, dimensions, photos, and ordering data.

31 MOLDING MACHINES

Watson-Stillman Press Div., Farrel-Birmingham Co.—A 24-page bulletin gives information on injection, compression, and transfer molding machines for the plastics industry; extrusion presses for ferrous and nonferrous metals; metalworking equipment; railroad shop equipment; ordnance equipment; standard and special machinery for general industrial applications.

32 PIPING SYSTEM DESIGN

M. W. Kellogg Co.—A 12-page booklet, "Piping Flexibility Analysis", shows how various flexibility analysis techniques can cut piping design and construction costs. The two basic techniques described are general analytical solution—manually or by electronic computer and piping model tester.

33 PACKAGE UNIT STEAM GENERATORS

Henry Vogt Machine Co.—Bulletin PSG-2 has line drawings, photos, and engineering data on portable type units from 10,000 lb per hr to 40,000 lb per hr steam capacities, in standard pressures of 175, 250, and 375 psig.

34 HIGH-STRENGTH STEELS

United States Steel Corp.—A 174-page manual discusses the essential principles of structural design and contains numerous formulas, charts and tables to assist in designing for high-strength steels. The hard cover, ring-bound book covers engineering considerations and fundamental characteristics of high-strength steels, design considerations, working unit stresses, tension, compression, shear, stresses in beams, deformation and deflection, formed sections and designing against corrosion.

35 HERRINGBONE GEAR REDUCERS

Lufkin Foundry & Machine Co.—New 24-page Catalog G-4 covering herringbone gear speed reducers and increasers gives engineering data, horsepower ratings and dimensions. Twelve sizes single reduction, 11 sizes double reduction reducers, 47 sizes speed increasers are included.

36 MEASURING EQUIPMENT

General Electric Co.—A new 40-page catalog, GEC-1016, describes many of the company's testing and measuring devices, including nuclear radiation instruments. Given briefly are product descriptions, specifications, and prices. This catalog is designed to serve as a handy reference guide for both laboratory and production-line needs.

37 WELDING CAST IRON

International Nickel Co.—An illustrated booklet, "A Handy Guide to Welding Cast Irons Quickly and Easily with Ni-Rod and Ni-Rod "55" Electrodes," describes emergency repair savings, maintenance welding cost cuts, salvaging defective castings, joining cast iron to other ferrous metals, and also contains tips on getting maximum machinability, production welding, and welding heavy sections.

38 PIPING SYSTEMS

Tube Turns—A technical bulletin gives the allowable stresses as used in the formulas of the ASME Boiler Construction Code (1952), Section I, and in the ASA Code for Pressure Piping B31.1-1955. The objective of the various codes is to prescribe a standard of minimum requirements for safe design of piping systems in such fields as power, industrial gas and air, oil, district heating, refrigeration and gas transmission.

39 WELDING ALUMINUM

Aluminum Co. of America—A 176-page, hard cover book gives basic, practical data on the various processes for welding aluminum with special emphasis on the inert gas methods. Included is guidance in selecting the process and the alloy. One chapter is devoted to the performance of welds. The book is profusely illustrated and contains 32 tables.

40 ELECTRONIC TEST INSTRUMENTS

Shasta Div. of Beckman Instruments, Inc.—A new eight-page catalog describes the firm's line of electronic test instrumentation including expanded scale voltmeters and frequency meters, vacuum tube voltmeters, oscillators, resistance bridges, power supplies, wide band amplifiers, WWV receiver, decade inductor, and various accessories.

41 PHOTOCOPY EQUIPMENT

Peerless Photo Products—An eight-page brochure illustrates and describes the line of Dri-Stat dry-process photocopying equipment for copying correspondence, incoming orders, invoices, and other kinds of typed or drawn originals. Included is a redesigned combination printer and processor, a new flatbed printer for copying from books, and new paper with which copies can be made under normal office light.

42 PLASTIC PIPE FITTINGS

Grinnell Co.—A 12-page catalog on corrosion resistant pipe fittings and flanges in normal impact grade and high impact grade, rigid, unplasticized polyvinyl chloride shows characteristics, advantages and limitations. Listed are operating pressures, temperatures, applications, price comparisons, fabrication advice, installation and supporting recommendations, dimensions and weights.

43 AUTOMATIC ENGINE CONTROLS

Synchro-Start Products, Inc.—No. 5 Catalog contains engineering information and includes dimensional drawings, photographic illustrations, hook-up diagrams and maintenance tips on full-automatic engine controls, alarm sets, governors, d-c solenoids, relays, oil and water temperature switches.

44 FIRE PROTECTION

Blaw-Knox Co.—Bulletin 2426 illustrates and describes a new spray sprinkler designed to reduce fire insurance costs by 50 to 90 per cent. Application, design and layout data on fire fighting systems is included.

45 GENERAL PURPOSE COMPUTER

Bendix Aviation Corp.—Bulletin 2-4 illustrates and describes all purpose computers for processing data, solving mathematical problems and for control functions. Model G-15 is a stored program, general purpose computer using an improved two address command system; with the addition of a complete digital differential analyzer the G-15 is an all purpose computer.

46 RIGHT-ANGLE BEVEL GEAR

Airborne Accessories Corp.—Brochure No. 56-A describes features of compact standardized right-angle drives for manual or powered transmission of rotary motion for industrial applications. It shows advantages of matched Coniflex gears, recommended duty ratings and data table for all models, and includes outline dimensions, cut-away model, and photos of typical installations.

47 ULTRASONIC TESTER

Sperry Products, Inc.—An eight-page bulletin covers applications of the ultrasonic Reflectoscope for nondestructive testing of products and equipment. It explains in simplified terms the principle of ultrasonic inspection and lists the latest types of equipment available.

48 INDUSTRIAL FURNACES

Bigelow-Liptak Corp.—An illustrated, three-color catalog features the company's unit suspended walls and arches for industrial furnaces. Special designs for steel mills, open hearth, billet heating, heat treating, oil refinery, heaters, cat crackers, coal preparation, dryer furnaces, boiler settings are shown.

For Consulting Engineers Turn to Page 184

YOUR

New Catalogs GUIDE

LATEST INDUSTRIAL LITERATURE

49 HEAT EXCHANGERS

Pfaudler Co.—Manual No. 837 illustrates and describes the firm's new standardized alloy designs of shell and tube equipment for application in the chemical and food industries. This equipment may be installed for any of the following uses: condensers, heat exchangers, heaters, evaporators, coolers and reactors. Selection data, system diagrams, specifications, construction, installation, operation and maintenance information is included.

50 FLUSH TYPE FIRE HYDRANTS

M & H Valve & Fittings Co.—Bulletin No. 17 describes flush type fire hydrant which sets completely underground, yet is readily accessible. It is used in airport runways and industrial areas to eliminate surface traffic interference and in residential sections where post-type hydrant is considered unsightly.

51 ELECTRIC WELDED PIPE

Alco Products, Inc.—An eight-page bulletin shows the firm's production methods, recent installations and gives specifications on electric welded steel pipe for water, gas and steam installations.

52 UNION CONNECTION

Jerguson Gage & Valve Co.—Two-page Data Unit No. 278 gives details and features of a new union connection. Connection is available as a special optional feature. It will compensate for up to 10 deg misalignment of vessel tappings in any direction from perpendicular axis and a wide variation in centers.

53 ENGINEERING MATERIALS

E. I. du Pont de Nemours & Co., Inc.—"Property and Application Data of Du Pont Engineering Materials," a comprehensive, illustrated booklet providing description, properties, end-use applications, and forming and working data of Zytel nylon resin, Teflon tetrafluoroethylene resin, Alathon polyethylene resin, and Lucite acrylic resin is available.

54 ALLOY TUBING

Babcock & Wilcox Co., Tubular Products Div.—Technical Data Card 163A furnishes technical information on 13 different analyses of tubing steels, including stainless, designed to overcome many problems which arise in high-temperature service. These analyses can also apply in other fields where temperature is not necessarily a determining factor, including chemical, paper, beverage, dairy, and food processing.

55 MULTI-PURPOSE JOINT

Emsco Mfg. Co.—Bulletin FS-120 illustrates and describes a two-piece ball bearing swivel joint for use on machine tool coolant lines, gasoline dispensing hose, paint spray lines, hose, liquid and air handling equipment.

56 GLOBE VALVES

Richmond Fdry. & Mfg. Co., Inc.—Gyroseal globe valves, featuring a spinning disk, dual purpose seat and line contact between seat and disk are illustrated and described in an 18-page catalog. Cutaways photos, drawings and tables of dimensions, chemical and physical properties of materials are included.

57 COUNTING DEVICES

Veeder-Root, Inc.—Modern mechanical and electrical counters for all industrial and special counting requirements are briefly described in a four-page condensed general catalog. Also contains information on applications and how-to-order.

58 CONVEYING & POWER TRANSMISSION

Link-Belt Co.—A 340-page guide of the firm's standard lines of power transmission and conveying equipment contains data on chains for conveying and power transmission, ball and roller bearings, enclosed gear drives, clutches, couplings. One section lists conveyor and elevator components. Also listed are vibrating screens, car icing equipment, car spotters, and power unloading scoops. Tables of pre-selected assemblies, concise capacity charts and dimension tables for all standard products are included.

59 AUTOMATIC VALVES

Golden-Anderson Valve Specialty Co.—A catalog of technical bulletins describes various types of automatic cushioned water and steam valves including water pressure reducing and regulating, surge relief, altitude control, float, solenoid, swing check, nonreturn, and steam pressure unloading valves. Each bulletin is fully illustrated with diagrams, tables and parts lists.

60 INDUSTRIAL WHEEL

Roll-Rite Corp.—Bulletin 302 illustrates and describes a new wheel which utilizes a molded rubber tread bonded vertically between two steel disks. By compressing the disks, a displaced and inflated tread is provided to support heavy loads in industrial materials handling applications.

61 ROLLER BEARINGS

Hyatt Bearings Div., General Motors Corp.—Catalog 150 illustrates and describes solid roller bearings, wound roller solid race and split race bearings, industrial inch bearings and solid roller bearings in separable inner race, separable outer race and nonseparable types.

62 REFRACTORIES

Norton Co.—A 32-page instructional manual illustrates and describes the application and suggested uses of Crystolon silicon carbide refractories in boilers. Included are curves of thermal conductivity and air flow through air cooled walls.

63 SPEED REDUCERS

Cone-Drive Gear Div., Michigan Tool Co.—Bulletin CD-400 describes double-enveloping worm gear shaft mounted speed reducers with capacities to 13 hp. Specifications, drawings, horsepower, and torque rating charts are included in the 12-page booklet. Details for motorizing all models (worm over or under, or gear shaft vertical) are provided.

64 HEAT EXCHANGERS

Niagara Blower Co.—Bulletin No. 132 on sectional Aero heat exchanger describes method for controlling temperatures and cooling fluids in industrial processes in a self-contained system independent of any considerable water supply; new apparatus, saving much in installation, equipment, and shipping costs is explained in four pages with diagrams and application photographs.

65 ECONOMY BOILER

Francis Steam Generator Co.—A 4-page bulletin illustrates and describes features of an automatic water-tube boiler with fast recovery for such applications as dry cleaners, laundries, bakeries, canneries, milk product plants, dairies, wineries, bottling plants, food processors, tire retreaders, feed mills, institutions. Diagrams show a dual circulation system and a preheated feed-water system.

66 BRONZE PUMPS

Oberdorfer Foundries, Inc.—A 24-page catalog illustrates and gives specifications of rotary gear, rubber impeller, and centrifugal bronze pumps. Capacity tables, dimension tables, cutaway photos and price lists are included. Sections deal with engineering data on each type of pump.

67 STEAM HEATING SYSTEMS

Warren Webster & Co.—A four-page folder, B-960, offers descriptive and diagrammatic material and specifications on a steam heating control of the pulsating flow type for two- or one-pipe installations in new or existing buildings. Outdoor thermostat controls length of interval during which steam is delivered to all radiators at fixed pressure distance.

68 SPEED REDUCERS

Foote Bros. Gear & Machine Corp.—An 80-page catalog, MD 456, lists dimensions and specifications for gearmotor and base-mount speed reducers from 1 to 150 hp, 1.8 to 780 rpm output speed. Single, double, and triple reduction units in both foot-mounted and flange-mounted designs are listed.

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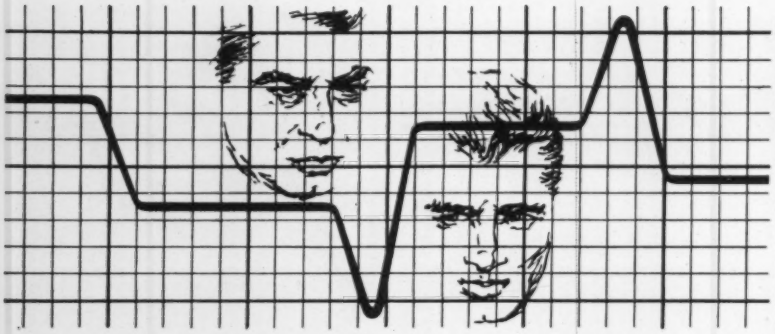

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Professionally and personally, engineers and scientists look to the future. They seek lasting, satisfying careers . . . not "jobs" that merely meet the needs of the moment. And this search inevitably poses the question: "What makes a desirable career?" For the man of real ability, this question becomes largely a choice of opportunities. He is the man we need and want . . . here is what we offer in return.

CHALLENGING OPPORTUNITIES—Our engineers and scientists work in the forefront of a unique field . . . the design and development of nuclear weapons. They meet and solve new and stimulating problems in a broad range of research and engineering activities.

PROFESSIONAL GROWTH—Close working relationships with outstanding leaders in many fields, coupled with the advanced nature of many of the projects involved, provide outstanding opportunities to acquire new knowledge and invaluable experience. Advanced study is encouraged, and courses are available locally.

COMPENSATION—Salaries at Sandia are competitive with those offered in other industry. Employee benefits include very liberal paid vacations, free group life insurance, sickness benefits, and a generous contributory retirement plan. Interview and liberal relocation expenses are paid by Sandia Corporation.

INDIVIDUAL ADVANCEMENT—Progress of Sandia engineers and scientists is reviewed at regular intervals, and promotions and salary increases are awarded on the basis of individual merit.

STABILITY—Sandia Corporation is a subsidiary of the Western Electric Company, operating Sandia Laboratory under contract with the Atomic Energy Commission. We offer permanent positions to graduate engineers and scientists.

WORKING CONDITIONS—Our engineers and scientists work in air-conditioned comfort in modern, well-equipped laboratories and shops, designed to provide every aid to effective operation.

LIVING CONDITIONS—Sandia Laboratory is located at Albuquerque, New Mexico . . . a modern city of 160,000, famous for its mild, dry climate. Albuquerque provides all metropolitan advantages, and recreational and cultural attractions abound. Housing is readily available.

CAREER OPPORTUNITIES NOW EXIST FOR:

Mechanical, electrical, and electronic engineers at all degree levels. Physicists and engineering physicists with MS or PhD degrees. Mathematicians at PhD level only. Aerodynamicists at MS or PhD levels, or BS with at least 5 years' experience.

IF YOU ARE INTERESTED IN WHAT THE FUTURE MAY HOLD FOR YOU AT SANDIA LABORATORY . . . we will welcome the opportunity to send you full details. Write:

STAFF EMPLOYMENT DIVISION 553A

SANDIA CORPORATION

ALBUQUERQUE, NEW MEXICO

YOUR *New Catalogs* GUIDE

69 AIR CONDITIONING

Frick Co.—Bulletin 80-D is a consolidated catalog of 36 pages featuring all sizes of commercial and industrial air conditioning, refrigerating, ice making, and quick freezing equipment. The bulletin has more than 150 illustrations, and includes eight useful tables. Short chapters discuss operating principles, Freon and ammonia compressors, low temperatures, industrial processes.

70 FORCE GAGE

W. C. Dillon & Co., Inc.—A six-page bulletin illustrates and describes a mechanical force gage designed to measure mechanical forces in either compression or tensile in limited space. Ranges 0–10 up to 0–50,000 lb with accuracy of within 1 per cent of indicated reading.

71 WATER TREATING EQUIPMENT

Hungerford & Terry, Inc.—A bulletin lists 16 recently published bulletins describing company's products in the water conditioning and waste water treatment fields. Bulletin includes photographs of company's products including electric control panels and automatic water conditioning units.

72 RECORDING SYSTEMS

Sanborn Co.—Oscillographic recording systems catalog describes eight-, six-, four-, two-, and one-channel models together with interchangeable preamplifiers available for use either in these systems or with other equipment. These preamplifiers include d-c coupling, carrier, a c/d c, servo-monitor, log-audio, low level stabilized d-c a-c wattmeter, input coupling network, rms volt/ammeter and 400 cycle frequency deviation.

73 STEAM TRAPS

Armstrong Machine Wks.—A 44-page manual on condensate drainage contains data on semi-steel and forged steel traps, discusses the fundamentals of good trapping, and deals with trap selection problems, installation, repair and trouble shooting.

74 SPEED REDUCERS

Winsmith, Inc.—Catalog 155, 112 pages, covers more than 150 models, including the recently introduced "C" series. It contains engineering selection data and is sectionalized for quick and easy reference to all information. A special general engineering section is included to aid in solving application problems.

75 TEST BOILERS

Besler Corp.—A four-page folder covers features and advantages of high temperature, high pressure test boilers, designed to deliver steam at full operating pressure and temperature in two minutes after starting cold. The units are described as extremely flexible, with one model handling any load from 500 to 15,000 lb per hour.

76 INSTRUMENT BALL BEARINGS

New Hampshire Ball Bearings, Inc.—Engineering bulletins cover specifications, lubrication, cleaning, assembly, materials, tolerances and torque of precision instrument ball bearings.

77 FLY ASH INTAKE VALVE

United Conveyor Corp.—Four-page bulletin 1-1-55 gives information on various stages of development and design of feeding inlet and intake valve for operation with pneumatic fly ash conveyors. It describes application for manual and automatic operation and lists features of present-day design.

78 MOLDED PARTS

Ohio Carbon Co.—Bulletin 1174 describes molded parts such as bearings, rings, molds, cores, seals for liquids, air and grease pumps, steam and water turbines as representative products that can be made from the company's new combination graphite carbon material known as KARAK. The parts are molded and machined in shapes and forms to user's dimensional and physical specifications. The material can be impregnated.

79 AIR COMPRESSORS

Pennsylvania Pump & Compressor Co.—Heavy duty, horizontal, single stage, water cooled air compressors in sizes from 10 to 125 hp for pressures to 150 psig are covered in 20-page Bulletin 201-D.

YOUR

New Catalogs GUIDE

80 VIBRATION CONTROL

MB Mfg. Co.—A 12-page catalog illustrates, describes and gives specifications on vibration isolators, engine mounts, vibration test equipment and vibration control engineering. Included is an isomode design chart to assist in finding mounting points for any product design.

81 RUBBER GROMMETS

Goshen Rubber Co.—A 16-page brochure lists and illustrates types and sizes of grommets available. All Air Force-Navy Standard AN931 series grommets, 34 basic sizes, each available with $^1/_{16}$, $^1/_8$, $^3/_{16}$ and $^1/_4$ in. groove width, and the 34 sizes in the web type with $^1/_{16}$ in. groove width are offered.

82 CONVEYOR SYSTEMS

Fuller Co.—Bulletin G-3, eight pages, pictures and describes conveying systems built by the company for handling dry, pulverized and granular materials. Diagrams showing how systems work are included. Also illustrates and describes rotary compressors and vacuum pumps, inclined-grate coolers and Humboldt preheater for handling dry, granular materials.

83 METERED LUBRICATION

Bijur Lubricating Corp.—A four-page bulletin "The ABC of Modern Lubrication" describes automatic lubricating system components. All systems consist of a lubricator, distribution system and a Meter-Unit for each bearing served. The bulletin describes lubricators for rotary, oscillating, hydraulic, solenoid, or hand operation.

84 INDICATING CONTROLLER

Foxboro Co.—Bulletin 5A-13 describes new M/41A pneumatic indicating controller for process temperature, pressure, liquid level and humidity. Bulletin 19-11 covers resistance bulbs. Bulletin 13-17 explains M/12A pneumatic temperature transmitter recently added to the company's line of pneumatic, electric and electronic instruments for indicating, recording and controlling industrial process variables.

85 AUTOMATIC VALVES

A. W. Cash Co.—A four-page bulletin, No. S-730, illustrates and describes 27 items of standard automatic valves and controls. These items are a portion of the complete line designed to meet every type of control problem.

86 AIR CYLINDERS

S-P Mfg. Corp.—Catalog 110 illustrates and describes a new line of air cylinders of square end, space saving design, available in 11 bore sizes from $1^1/_2$ through 14 in., and with 21 types of mountings. They are designed to JIC standards and feature brass tubes, removable bronze cartridge containing wiper and rod packing, and cold rolled steel end plates.

87 VIBRATION ISOLATION

Korfund Co.—A four-page bulletin gives information on how to write vibration isolation specifications for air conditioning and related equipment. It contains a definitive treatment of the factors involved in the selection of various isolation media commercially available and has a selector chart designed to simplify writing specifications.

88 SWITCHES, CONTROLS

Fenwal, Inc.—A 16-page catalog describes electrical temperature control, detection and indicating devices, including local and remote liquid-filled snap action units, electronic and mechanical indicating controllers, thermostats.

89 HIGH-SPEED SCREWS

Bergander Mfg. Co.—Catalog illustrates and describes Gulmite screws, nuts, finishing washers and tools for high-speed assembly. Screws are manufactured in all standard types with five standard styles of heads. Dimensional data is given.

90 FLEXIBLE COUPLINGS

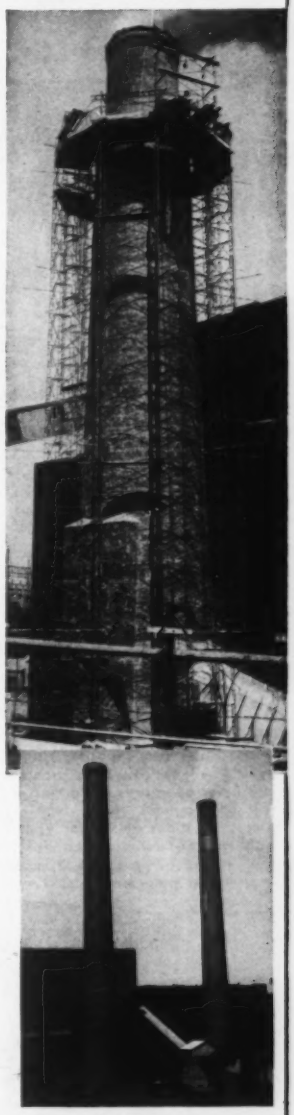
American Flexible Coupling Co.—Twelve-page Form 12 contains case histories on power transmission applications using Amerigear couplings. Included are applications in heavy mill service, high-speed turbines, hydraulic presses, power supplies.

CONSOLIDATED builds
a Chimney around an Operating Chimney!

A large Eastern utility greatly expanded the generating capacity of one of its important stations and needed two new 250 ft. x 13 ft. inside top diameter radial brick chimneys for the new and larger boilers. At the same time it was necessary to keep the old boilers operating with their existing 150 ft. chimney.

Consolidated engineers and construction crew met the situation by erecting one of the new 250 ft. chimneys and building the greater portion of the second around the older operating chimney. The original chimney continued in operation until the new chimney was erected to the same height; then the top 100 ft. was completed in a 7 day shut down period!

This is just one more example of Consolidated's engineering skill and adaptability to the requirements of the job and the service required. Many hundreds of Consolidated Chimneys have been designed and built for leading companies and larger contractors throughout the United States, in Canada and in Mexico. Designed by men who know their business, erected with painstaking care and skill to exact specifications, Consolidated Chimneys give performance and service year in and year out to meet the most exacting requirements.



Upper photo shows the building of the new 250 ft. radial brick chimney around the existing 150 ft. chimney. Note outside tubular pipe scaffolding. The original chimney continued in operation until the new chimney was erected to the same height as the existing one. Then the top 100 ft. was completed in a 7-day shut down period.

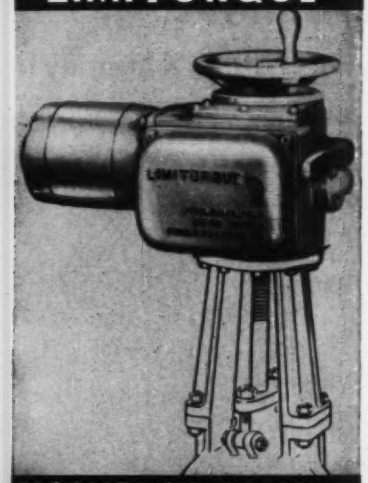
Lower photo shows the two completed Consolidated chimneys in operation. The chimney at right is one built around the old chimney; chimney at left was erected at the same time. Both chimneys are of radial brick construction 250 ft. x 13 ft. inside top diameter.

Consolidated designs and builds chimneys of all types and all sizes—Perforated Radial Brick, Tapering Reinforced Concrete, Face and Common Brick, Acid Proof, High Temperature; installs linings for steel stacks, waterproofs, repairs and rebuilds, installs lightning rods and aircraft warnings; demolishes chimneys. Whatever your chimney problem may be, Consolidated has the experience, the knowledge and the skilled personnel to handle it.

Phone, wire or write today *for information. Ask for catalog giving installations, engineering service, chimney design data and specifications.*

CONSOLIDATED CHIMNEY COMPANY
Engineers and Builders
6 South Dearborn Street, Chicago 3 • Telephone RAndolph 6-6222
New York, N. Y., 545 Fifth Avenue • Telephone Murray Hill 7-6867
Detroit, Cleveland, Minneapolis, Richmond, Va.

LIMITORQUE



VALVE CONTROLS

push-button operation

Here's a completely automatic, dependable, low cost valve operator for small valves. Size-for-size, the types SMA-00 and SMA-000 Limitorque Valve Operators are designed for greater valve stem capacity; will produce more stem torque, and withstand greater thrust than any other operator on the market. They are readily adaptable to all types of valves—gate, plug, globe and botterfly; and they have many of the exclusive features which have made the larger Limitorque Operators the most widely used in the world.

Send for Catalog L-550 and see why this and other types of Limitorque Valve Operators are so widely used.

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ERIE AVE. AND G ST., PHILADELPHIA 34, PA.
NEW YORK • PITTSBURGH • CHICAGO • HOUSTON • LYNCHBURG, VA
BALTIMORE • CLEVELAND
Limitorque Corporation, Philadelphia
Industrial Gears & Speed Reducers • Limitorque Valve Controls
Established 1903

YOUR

New Catalogs GUIDE

LATEST INDUSTRIAL LITERATURE

91 DEMINERALIZATION

Graver Water Conditioning Co.—Bulletin WC-111, 22 pages, covers chemical and mechanical factors entering into the design and operation of demineralizing plants for obtaining the highest quality process water and boiler feedwater from a wide range of water supplies under many different operating conditions.

92 RUBBER DATA

Acushnet Process Co.—A 32-page catalog covers the company's manufacturing and testing facilities and applications for molded products of various synthetic rubbers. Included are properties tables of rubbers and compounds, data on methods of molding and a glossary of rubber terms.

93 FRACTIONAL-HORSEPOWER GEARS

Gear Specialties, Inc.—A 6-page bulletin illustrates and describes complete facilities together with different types and applications of G.S. small gears from 8 to 96 diametral pitch. Several diametral pitch and circular pitch charts included.

94 CONVEYORS, DUST CONTROL

Dracco Corp.—Information is provided on a variety of airstream conveyors and dust control systems now in operation for handling many dry, bulk materials. Solution of material waste and air pollution problems by dust control is described.

95 LP-GAS CYLINDERS

Linde Air Products Co.—An eight-page sales folder entitled "Prest-O-Lite Cylinders for LP-Gas" contains descriptions and specifications of the following types of cylinders: standard cylinders, special cylinders, cylinders for lead melting furnaces, cylinders for lift truck service, and cylinders for tractor service.

96 BALL BEARINGS

Fafnir Bearing Co.—A new 168-page general catalog and engineering manual features dimensions, tolerances, load ratings, suggested applications and typical mountings of the entire Fafnir line of ball bearings and ball bearing power transmission units. Included also is comprehensive engineering data, as applicable to the use of ball bearings.

97 PUMP SELECTION GUIDE

Aurora Pump Div., New York Air Brake Co.—A booklet provides illustrations and data on turbine-type and centrifugal pumps, telling special features of each, and referring to the company's technical literature covering each classification.

98 LUBRICATED PLUG VALVES

Wm. Powell Co.—Catalog PV-4, 35 pages, illustrates and describes steel, semi-steel and alloy lubricated plug valves for quick, positive shut-off of erosive or corrosive fluids. Seating surfaces are not exposed in open position so that gritty suspensions may be handled readily. A quarter turn will close or open the valve. Included are single gland, screwed gland, and bolted gland types.

99 FLEXIBLE METAL HOSE

Atlantic Metal Hose Co.—Bulletin 20-E covers corrugated flexible metal hose of annular and helical construction. Steel and bronze hose, with and without metal braid, couplings and assemblies are described. Applications listed are for vibration absorbing, misalignment connecting, high pressure use, oil burner and gas furnace connections, handling compressed air, steam, solvents, chemicals, refrigerants, gasoline, searching liquids, caustics, ammonia.

100 GRAY IRON PROPERTIES

Gray Iron Founders' Society—The mechanical and engineering characteristics of gray iron, including details for designing cast components, are given in a 12-page booklet. The relation between casting section and properties is given, including figures on endurance and other design data. A list of available literature is included.

101 COPYING MACHINE

Ozalid, Div. of General Aniline & Film Corp.—Six-page illustrated pamphlet features new Streamliner 400, a low cost, all-purpose copying machine providing dry reproductions from anything translucent up to 42 in. wide. Printing and developing are synchronized to 24 fpm for drawings, maps, manuals, and specification sheets.

102 GEAR PRODUCTION EQUIPMENT

Fellows Gear Shaper Co.—General catalog of 20 pages and 50 illustrations describes and gives specifications for machines for cutting and finishing gears, and instruments for gear inspection. Information on special attachments, gear shaper cutters, and shaving tools is included.

103 STEEL, ALLOY FABRICATIONS

Graver Tank & Mfg. Co.—A four-page folder illustrates fabricating services to the chemical, process, and petroleum industries. Illustrated is equipment ranging from field-erected storage tanks and bins to complex shop-built processing equipment. One page is devoted to plant construction.

104 FIRE PROTECTION SPRINKLERS

"Automatic" Sprinkler Corp. of America—"Engineered Special Hazard Fire Protection," 28 pages, describes the company's types of sprinklers for dispersing fog, foam, high- and low-pressure carbon dioxide, and dry chemical. Properties and recommended applications are discussed. A two-page reference table is included.

105 SEAMLESS METAL HOSE

Seamlex Co.—Four-page Bulletin 955 gives essential information on bronze hose from $^1/_{16}$ to 8 in. ID and diesel exhaust hose from 2 to 20 in. ID. Fourteen illustrations show cross sections of hose and fittings. Two tables give technical data. Tabulated service classification serves as aid to writing hose specifications.

106 INDUSTRIAL PERISCOPES

Kollmorgen Optical Corp.—Bulletin 301 illustrates and describes industrial periscopes for special assignment in remote viewing. Sketches show three types: vertical walk-around, vertical fixed-eyepiece, and horizontal wall periscope.

Read the various items listed . . . one catalog may hold the solution to your present problem . . . and select those of interest to you. *Distribution by us to Students is not included.*

The coupon on page 44 must be mailed on or before May 15th.

YOUR *New Catalogs* GUIDE

107 SLUDGE REMOVER

Chain Belt Co.—Bulletin 315-81 describes and illustrates Unitube Two-Bro sludge remover, designed for use in the final clarifier tanks of waste treatment plants. The firm says the new unit is lower priced and more efficient than previous header and nozzle type collectors.

108 DRAFTING SYSTEM

Universal Drafting Machine Corp.—Literature covers a new portable drafting system, consisting of a personal size professional drafting machine, folding drawing board, metal scales, instrument box and travel case, which can be set up on a desk in two minutes. The system, called Desk-Topper, is designed for use at home, in the office or hotel room, or on planes or trains.

109 DRY POWDERED MIXERS

Patterson-Kelley Co.—A 12-page catalog describes patented twin shell blenders. Illustrations and dimensional outlines are given for the various models. Sequence photographs showing rapid mixing action of this blender are included. Also described are double cone blenders; ribbon blenders; synthetic resin pilot plants; and heat exchangers.

110 METAL PARTS DRY CLEANER

Curran Corp.—A catalog sheet describes Carbon Met as a replacement for carbon tetrachloride for degreasing motors, generators and electrical components. The material is said to have low toxicity, nourust inducing qualities and nonpolar properties.

111 SEPARATORS, EXHAUST HEADS

Wright-Austin Co.—Catalog 400 covers separators, exhaust heads, traps and strainers, boiler trimmings for steam, air, gas, oil or water service. Cutaway photos, dimensional drawings and tables are used to show the features of the equipment.

112 GAS AND AIR COMPRESSORS

Cooper-Bessemer Corp.—Bulletin M-70, 40 pages, presents M-line compressors for transmission of gas and air. Installation photos show these units in use on pipelines, in refineries and chemical plants, and uses for air compression in industry. Cross sections and cutaways are included for many of the available types.

113 TESTING DEVICES

Baldwin-Lima-Hamilton Corp.—Bulletin 4300 lists SR-4 devices and equipment for load, torque and fluid pressure measurement and control. Numerous application photos in all fields are included in this 20-page bulletin.

114 NEEDLE BEARINGS

Torrington Co.—Comprehensive 76-page catalog presents design, application and use data for 5 types of needle bearings. An engineering short course on bearings, it is organized for practical use in properly selecting needle bearings by type, size and suitability. Index visual units quickly identify the various bearings. Construction, materials, finishing, housing and shaft requirements, fits, load capacity, speeds, and recommended installation are detailed.

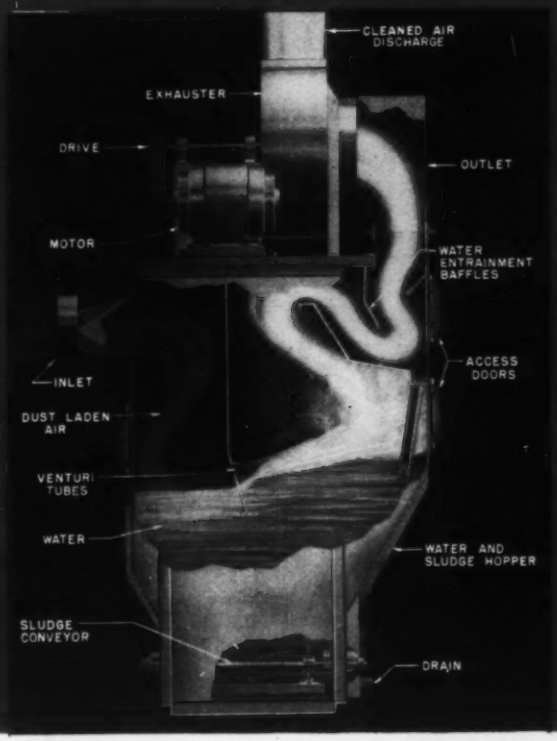
115 INDUSTRIAL FANS

American Blower Corp.—Bulletin 5306 describes new Series 106 industrial fans which provide complete full range coverage of industrial air and material handling requirements. Features, construction, and complete dimension and weight tables are shown along with selection data and ratings. A completely self-contained packaged industrial fan is similarly described.

116 VALVES, FITTINGS, ASSEMBLIES

OPW Corp.—An 88-page catalog, No. 18, includes detailed information, engineering data, recommendation charts and conversion tables, besides listing 322 products. This index tabbed catalog, designed as a convenient working tool, contains descriptions, specifications, sectional drawings and diagrams which enable the engineer to select the proper type of product for his specific liquids handling application.

NEW PANGBORN VENTRIJET
Gives Efficient Wet Dust Control



Efficient wet dust collection depends on breaking water into particles and mixing it with the dust. The new Pangborn VENTRIJET Collector utilizes venturi tubes to achieve this effect. As dust-laden air enters the inlet chamber, heavier dust particles sink to the bottom. The air stream then passes through the venturi tubes at high velocity, drawing water with it and breaking it into minute particles. These particles mix thoroughly with the remaining dust in the air and give the VENTRIJET its high operating efficiency. In the outlet chamber, the resulting sludge settles to the bottom for removal. Eliminator sections remove water droplets in the washed air and the cleaned air is then discharged. The result is peak performance in a minimum of space.

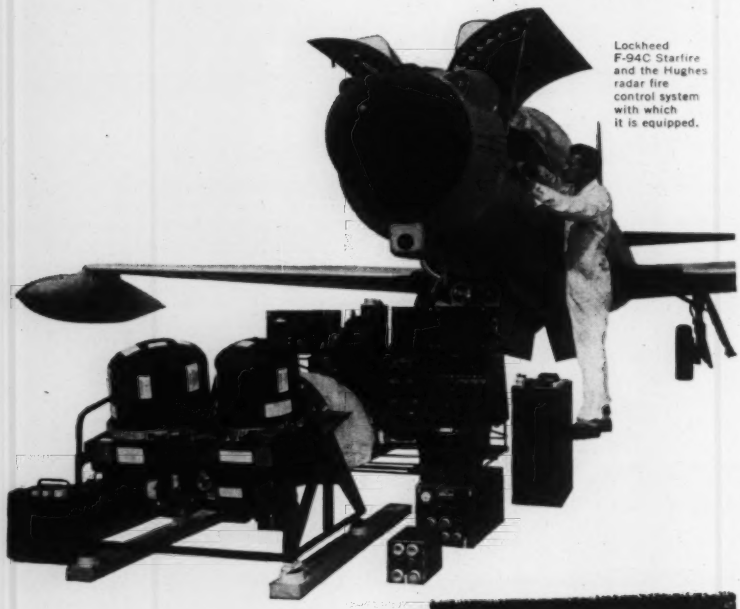
Pangborn VENTRIJET offers these advantages:

- **Complete, self-contained unit with low headroom, minimum floor space**
- **High air velocity through venturi tubes insures thorough mixing of air and water**
- **Venturi tube design results in minimum pressure loss and provides uniform flow—no narrow channels to become choked with sludge**
- **Tube design and thorough washing action enable collector to handle heavy loads.**

For full details, write to PANGBORN CORPORATION, 2200 Pangborn Blvd., Hagerstown, Maryland.

Visit "Pangborn Institute" at AFS Show, Atlantic City, May 3—9

Pangborn CONTROLS DUST



Lockheed F-94C Starfire and the Hughes radar fire control system with which it is equipped.

Hughes has been the leader from the beginning in applying electronic computers to airborne fire control equipment. Today every U.S. Air Force and Canadian continental defense interceptor uses Hughes-developed and Hughes-manufactured systems.

PRODUCT DESIGN at HUGHES

As the intercept problem becomes more and more automatic, additional equipment such as new-type computers, control surface tie-in (CSTI), autopilots, and other units must be integrated into the system. Faster speed and heavier engines dictate more streamlining—and hence less space for electronic gear. The result is even more miniaturization and compact packaging, evolved from special techniques.

This all means that now the product design engineer is more important than ever before. In the Product Design Laboratory he is a vital part of the formal link between the Research and Development activity and the optimum configuration and installation arrangements for the systems "black boxes."

Write to HUGHES *for information regarding positions open.*

SCIENTIFIC STAFF RELATIONS

HUGHES RESEARCH AND DEVELOPMENT LABORATORIES

CULVER CITY, LOS ANGELES COUNTY, CALIFORNIA

YOUR *New Catalogs* GUIDE

117 CLUTCHES, COUPLINGS

Hilliard Corp.—Catalog MP-5 lists and illustrates a line of industrial clutches and couplings including slip clutch, over-running clutch, single revolution clutch, and automatic centrifugal coupling. Brief description of operation is a guide to suggested applications of each item.

118 COPPER, COPPER ALLOY

American Brass Co.—A 24-page reference manual contains copper and copper-alloy specifications, including ASTM, ASME, AWS, SAE, AMS, federal, military, Army, Navy and joint Army-Navy specifications.

119 LABORATORY PRESSES

Wabash Metal Products Co.—A four-page bulletin describes the line of manually operated and powered hydraulic laboratory presses from 3 to 50-tons capacity. Heated platens, sensitive pressure and temperature gages, applications, typical users and construction features are described.

120 AIR FILTERS

R. P. Adams Co., Inc.—An eight-page bulletin illustrates and describes Poro-Stone filters for compressed air and gases. Included is data on a filter in which compressed gas is used to achieve initial separation. Second stage separation is by diffusion through a permanent element which is unaffected by oil or moisture. It has no moving parts.

121 RETAINING RINGS

Waldes Kohinoor, Inc.—A new 8-page catalog supplements the company's 52-page catalog covering Waldes Truarc retaining rings. The two catalogs include 33 pages of engineering and specification charts, 6 pages of field applications and case histories, 20 pages devoted to Truarc pliers, assembly, and accessory tools, and other relevant information pertaining to the most advantageous use and selection of the rings.

122 INDUSTRIAL PLASTICS

H. N. Hartwell & Son—Catalogs and technical bulletins describe Boltaron 6200 corrosion resistant unplasticized polyvinyl chloride sheet, pipe, pipe fittings, valves, bars, blocks, and welding rod, as well as Boltaron 7200 modified high impact PVC sheet and pipe materials.

123 ADJUSTABLE HOLE CUTTER

Erwood, Inc.—A bulletin covers a new industrial wood and metal working tool for use with heavy duty wood working equipment to cut holes quickly and accurately from $2^1/_4$ to 5 in. in diameter. The unit, which is an adjustable die saw, may also be used for plastics.

124 AFTERCOOLERS

Niagara Blower Co.—Bulletin No. 130 on Aero aftercooler describes and illustrates new apparatus for removing moisture from compressed air or gases, reducing temperature below the atmospheric, preventing condensation in compressed air lines. Also illustrated is application to air liquefaction systems.

125 DUST FILTERS

Koppers Co., Inc.—Bulletin 304 illustrates and describes the Model D Aeroturn dust filter. The unit has automatic, pressure-controlled, reverse-air-jet filter cleaning, and is said to be the most compact dust filter for its capacity ever made.

126 MINIATURE BALL BEARINGS

Miniature Precision Bearings, Inc.—A new 24-page, 3-color catalog, illustrated with comprehensive specifications on more than 500 types and sizes of standard miniature ball bearings from $1^1/_2$ mm to $^3/_8$ in. OD, includes material of particular interest to designers of precision mechanisms—applications, lubrication, design variations, special bearings, etc.

127 PIPELINE APPLICATIONS

Ladish Co.—A 21-page manual provides data on five fittings developments for pipeline and petroleum industry applications. The developments concern hot tap reinforcing tees, multiple outlet headers, extra long radius elbows, pipeline anchor flanges, seamless multiple outlet headers.

When products can be designed with less material...

Have greater strength and rigidity...

Yet cost less to manufacture...

WHY

aren't more of your products designed for welded steel?

Ask

THE LINCOLN ELECTRIC COMPANY

Cleveland 17, Ohio

Pioneer in Welded Structural Design ...for Lower Cost

YOUR *New Catalogs* GUIDE

128 QUENCHING OIL

Gulf Oil Corp.—A 24-page brochure, "Gulf Super-Quench," describes function of dual-action quenching oil for a wide range of steels. It explains mechanism of heat removal, effect of variation in bath temperature, degree of agitation, mass effect on depth of hardening. Charts and curves depict comparison with several quenching media. Tests to determine depth of hardness, distortion and cracking are discussed.

129 STRAINERS

Andale Co.—Bulletin 461-S covers cast steel duplex oil strainers, sizes 1½ to 8 in., with duplex three-way plug valve with ball bearing jack for lifting and seating plug. Working pressures are 1300 psig at 100 F to 900 psig at 500 F. Dimensions, sections, parts list, and charts for pressure loss determination are included.

130 INDUSTRIAL PRODUCTS

American Brake Shoe Co.—First complete catalog, 48 pages, 2 colors, illustrates representative parts produced by eleven divisions of the company and details physical properties or characteristics. The catalog contains sections on ferrous castings, non-ferrous castings, bearing materials, sintered metals, steel forgings, welding products, air compressors, industrial pumps, dredge pumps, and railroad products.

131 ELECTRIC MOTORS

Allis-Chalmers Mfg. Co.—Catalog 51B6052 is designed to help determine the electrical and mechanical characteristics desired in commonly used motors and to indicate availability of less frequently used types and larger motors that may solve more involved application problems.

132 STAINLESS STEELS

G. O. Carlson, Inc.—A four-page folder shows applications of stainless steel in plates, plate products, heads, rings, circles, forgings, flanges, bars, sheets. Products, equipment and services of the firm are discussed.

133 REVOLVING UNIT HEATERS

L. J. Wing Mfg. Co.—Bulletin HR-6A describes revolving unit heaters which feature a revolving air-distributor with one or more outlets. Models are available for steam, hot water, and electric and gas heat supply in a full range of sizes. Also can be used for summer cooling. Design and construction details are included.

134 DEAERATOR

Permutit Co.—Bulletin No. 3677 describes the company's reboiling deaerator with direct contact internal vent condenser which operates efficiently over a wide range of flows. The three stages of deaeration are described and well-illustrated. The unit is designed to protect equipment from corrosion by removing oxygen, carbon dioxide and nitrogen.

135 EXPANSION-JOINT DESIGN GUIDE

Flexonics Corp.—A 24-page Flexon Expansion Joint Design Guide, Catalog 153, covers engineering application and selection data necessary to the proper solution of pipeline expansion problems. Features of the Flexon Design Guide include a discussion of the various types of expansion joints on the market, the many types of Flexon Expansion Joints available, and types of pipeline motion solved by expansion joints; also expansion joint design considerations, installation instructions, and selection data. The new line of Model H compensators is completely covered. The center spread of the catalog is devoted to a schematic piping layout illustrating various expansion joint applications and principles.

136 SPRING CLUTCHES

Marquette Metal Products Co.—A pocket-sized manual illustrates and discusses the basic principles of spring clutches and their design. Included are diagrams of various types of spring clutches, along with application data.

Use a CLASSIFIED ADVERTISEMENT for Quick Results

What's your need for heat?

Whatever your heating job may be, you'll find the efficient, economical answer in . . .

CHROMALOX Electric Heaters

. . . for heating platens, dies, molds, metal parts . . . for heating liquids, air, gases . . . for curing, drying, baking . . . for comfort heating in offices and factories . . . for special applications . . . in fact for any application requiring fast, low-cost, controlled heat up to 1100°F.

IMMEDIATE DELIVERY

from the world's largest factory stock of industrial electric heaters . . . over 15,000 types, sizes and ratings.

Let the Chromalox Sales-Engineering staff solve your heating problems . . . electrically.

Write for your copy of Catalog 50

Contains helpful information on design uses, and prices of Chromalox Electric heaters, elements, thermostats, contactors and switches.

To get some interesting facts about additional applications of electric heat, ask for Booklet F1550—"101 Ways to Apply Electric Heat."

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New Catalogs GUIDE

LATEST INDUSTRIAL LITERATURE

137 NON-MELTING GREASE

Shell Oil Co.—Actual case histories from various industries—textile, steel, paper mills, and a manufacturing plant—are described in a 4-page folder, outlining the properties of Darina Grease 2, a non-soap inorganic jelled grease having no melting point, that may be used in wet or dry applications at temperatures up to 350 F.

138 PLASTIC STEEL

Chemical Development Corp.—A folder illustrates and describes applications for Devcon, a combination of 80 per cent steel and 20 per cent plastic, for use in making jigs, molds, models, fixtures, forming dies, rebuilding machinery and salvaging metal parts. The material, which handles like modeling clay, hardens into a rigid metallic piece in approximately two hours. No heat or pressure is required.

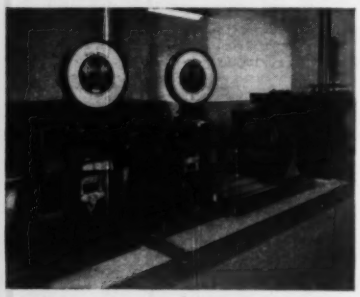
139 DRAFTING ROOM EQUIPMENT

Hamilton Mfg. Co.—Catalog No. 14 lists steel and wood drawing tables and files for every drafting room need. It includes comprehensive data on the Auto-Shift drafting table, and information about the shallow-drawer unit with tracing lifter.

ROCKFORD

MEMO- Clutch must maintain it's torque

ROCKFORD CLUTCHES, of all types and sizes up to 18", are thoroughly tested for torque capacity — with this powerful, accurate Dynamometer. Arranged with an Automatic



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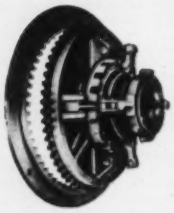

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Cycling Device, this Dynamometer is also used for severe wear testing of facings, linkage, splines, etc. Let ROCKFORD engineers utilize our extensive clutch testing equipment to develop more efficient clutches for your products.

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Clutch Division
BORG-WARNER
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CLUTCHES

140 FLEXIBLE COUPLINGS

Ajax Flexible Coupling Co.—Bulletin 60 introduces a new line of series 3-D dihedral self-aligning couplings, designed to handle misalignment up to 3 deg between driving and driven shafts of direct connected machines. They are designed for NEMA motor shafts using standard keys.

141 SUPER REFRACTORIES

Carborundum Co., Refractories Div.—"Properties of Super Refractories," twenty-four pages, covers latest data on super refractories including newly developed compositions for specialized applications. Re-frax silicon-nitride bonded silicon carbide refractories which can be produced in intricately designed shapes to close dimensional tolerances is described. Chemical analysis and physical property charts are provided on all materials.

142 ENGINEER'S HANDBOOK

Chase Brass & Copper Co.—Catalog is designed as an aid in the laying out of hot and cold water lines, radiant heating and soil, waste and vent lines systems. It contains roughing-in drawings and dimensions for the complete line of cast, wrought and drainage solder-joint fittings. Data on copper water tube including flow charts, flow capacities, friction loss is listed along with architectural specifications, soldering information and copper drainage tube information.

143 AIR CONDITIONING

Clarage Fan Co.—Illustrated 24-page catalog describes the new line of Unicoil units—sprayed coil equipment for central station air conditioning systems. Complete with sample calculations and convenient charts. Unicoils combine in a single assembly all elements necessary for efficient heat transfer.

144 PNEUMATIC MARKERS

Pannier Corp.—A data sheet illustrates and describes single stroke pneumatic markers for hot metal stamping. Photos, specifications and a discussion on the features of the units are included in the bulletin, designated C-14.

145 SPHERICAL ROLLER BEARINGS

S K F Industries—Bulletin 365 discusses in detail the company's improved (Type C) spherical roller bearing said to increase capacity 25 to 50 per cent and service life 2 to 3½ times. A tabulation of capacity comparisons, and life comparisons between the original spherical design and the Type C is also given.

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New Catalogs

LATEST INDUSTRIAL LITERATURE

GUIDE

146 INDUSTRIAL HEATER

Prat-Daniel Corp., Thermobloc Div.—A 4-page folder illustrates the firm's infra-red radiant industrial heater for warehouses, garages, industrial plants, shopping centers, showrooms, commercial buildings. Another bulletin explains and describes the company's warm air heaters for industrial use.

147 THERMOSTATIC BIMETAL

W. M. Chace Co.—A 36-page illustrated booklet describes and explains twenty-two uses of the company's thermostatic bimetal as regulating, controlling or actuating elements in temperature responsive devices. Included are ten pages of engineering data for element design and selection.

148 FORGINGS

United States Steel Corp.—A booklet illustrates and describes the manufacture and application of generator, turbine and waterwheel forgings, anvil bases and columns, forged shafts, forged steel rolls and sleeves, forged blooms, billets and rounds, and miscellaneous forgings. A history of forging is included in the booklet.

149 METAL FASTENERS

Standard Pressed Steel Co.—Catalog pictures and describes the Unbrako line of precision socket screw products and points up the savings in time and money in using standards instead of specials. Also included are pressure plugs and dowel pins.

150 BELLOWS ASSEMBLIES

Clifford Mfg. Co.—A file folder illustrates and describes representative bellows devices. Included is a chart detailing the sizes and characteristics of the 20 most commonly used bellows, and a comprehensive discussion of designing with metal bellows.

151 FORGING HISTORY

Drop Forging Assn.—"What is a Forging?" is an eight-page booklet which covers the advantages of producing metal parts by forging. Also included is a history of forging.

152 PROCESS CONTROL SYSTEM

Swartwout Co.—A bulletin covers equipment for an all-electronic control system for process and power instrumentation. It can be used with a-c, d-c or motion inputs, as well as the conventional primary elements. In addition to various components, a discussion of electronic transmission and control is included.

153 MEDIUM-HEAD PUMPS

C. H. Wheeler Mfg. Co.—An eight-page bulletin illustrates and describes Wheeler-Economy Type M pumps for medium and high head services. Cross sections of design are shown for bottom suction and side suction types.

154 ANALOG TO DIGITAL CONVERTER

Norden-Ketay Corp., Instrument and Systems Div.—Four-page bulletin No. 372 has applications, characteristics and installation drawing of ADC-1A analog to digital converter. The converter described has an unambiguous output of 13 binary digits and operates at high speed in clockwise or counterclockwise operation.

155 RUBBERIZED ABRASIVES

Cratex Mfg. Co.—The application, adaptability and versatility of rubberized abrasives especially designed for burring, smoothing and polishing operations are set forth in catalog No. 53. Available in wheels, blocks, sticks, cones, and points for machine or hand operations in all industries, the products, uses and grit types are fully presented and illustrated.

156 STEEL RESERVOIRS

Chicago Bridge & Iron Co.—A revision of the brochure, "Horton Steel Reservoirs and Standpipes," 24 pages, illustrates installations of capacities from 50,000 to 10,000,000 gal with cone, umbrella, ellipsoidal roofs and ornamental structures with special architectural features. The brochure also contains a table of standard capacities and detailed information on foundations.

157 MULTI-V-BELT CARE

B. F. Goodrich Co.—A 14-page illustrated manual covers the care and maintenance of industrial V-belts. A service chart which illustrates the typical causes of belt failure is featured, and ways to prevent belt failure are outlined.

158 CASTINGS HANDBOOK

Meehanite Metal Corp.—A revised handbook has a new section entitled "Principles of Casting Design." The handbook also gives an up-to-date tabular summary of the physical properties of metal castings as well as a description of the metallurgy and interpretation of the engineering properties of the various types of metal and their applications in industry.

159 METERS, PUMPS

Granberg Corp.—A four-page bulletin, No. 551B, illustrates and describes rotary positive displacement meters and pumps for the petroleum industry. Included are photos and specifications for meters and pumps for both tank trucks and bulk plants. Accessories are also listed.

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YOUR New Catalogs GUIDE

160 PRESSURE REDUCING VALVES

Spence Engineering Co.—A four-page bulletin describes two models of direct-operated water pressure reducing valves for dead-end water service where flow is intermittent and subject to abrupt fluctuation. Pressures range from 30–80 psi and 10–50 psi.

161 AIR CONDITIONING EQUIPMENT

Servel, Inc.—Catalog describes Servel gas and steam operated air conditioning equipment and supplies specifications, dimensions and other application data. Equipment included are all-year air conditioners with both cooling and heating, 25-ton water chillers for process cooling and air conditioning, and evaporative water coolers.

162 HIGH-STRENGTH STEEL

Jones & Laughlin Steel Corp.—A booklet presents Jalten, a versatile low-alloy high-strength steel said to have light weight, abrasion and corrosion resistance and easy weldability. Application data is illustrated and described and tables show specifications.

163 PAPER STOCK PUMP

Ingersoll-Rand Co.—Bulletin No. 7325-A describes a new, single-stage, centrifugal pump. Designed for handling liquids containing solids, air or gases, it features a diverging type impeller with few blades. Capable of handling paper stock at consistencies up to 10 per cent, it also handles chemicals, foods, sugar syrups, liquids, petroleum products, paints and varnishes without any of the usual difficulties.

164 MINIATURE MECHANICAL CHAIN

Sierra Engineering Co.—Catalog describes miniature mechanical chain and sprockets, gives engineering data on chain which operates smoothly around a 7-tooth sprocket with a root diameter of .250 in. and has pitch of .1475 in. The unit is for use where precise motion control is needed in miniature assemblies, especially where motion is to be transferred through several planes simultaneously.

165 PACKAGED STEAM GENERATORS

Superior Combustion Industries, Inc.—Packaged fire tube steam generators are described in detail and with illustration in a 16-page catalog with a special foldout cover. Data, dimensions and specifications for units in 18 sizes from 20 to 600 bhp and for operation burning oil or gas or both are included.

Make use of this Free LITERATURE SERVICE

Select desired Catalogs by number. Requests limited to 25 catalogs. Fill in coupon on page 44 and mail promptly.

YOUR

New Catalogs

GUIDE

166 INDUSTRIAL SPRAY NOZZLES

Spraying Systems Co.—Catalog No. 24, a new spray nozzle catalog, contains capacity and spray characteristic data. Said to be the most complete industrial spray nozzle catalog ever produced, it illustrates nozzles for producing hollow cone, full cone, flat, solid stream, and pneumatically atomized sprays. Nozzles made of special materials are also illustrated with capacity tabulations, such as nozzles with wearing points reinforced with tungsten carbide.

167 CENTER GUIDED CHECK VALVE

Miller Valve Co., Inc.—An eight-page bulletin illustrates and describes the Streamflow center guided check valve, said to be silent and shockproof, and which can be installed vertically or horizontally. Specifications and dimensions are tabled.

168 BALL BEARINGS

T. B. Wood's Sons Co.—Life-Lube bulletin No. 699 illustrates with dimensional information pillow blocks, flange units, take-up units. These standard 200 series bearings with wide inner ring, deep ball race groove are lubricated for life at the factory. They are completely self-aligning. Sizes range from $^1/_2$ to $2^{15}/_{16}$ in.

169 O-RINGS

National Motor Bearing Co., Inc.—This National O-Ring Catalog is designed for broadest usefulness in all types of O-ring applications. Includes practical working information about O-ring applications, sizes, groove dimensions, back-up rings, and dust seals, and lists all National O-Rings and local National Motor Bearing offices.

170 PLANT CLEANING GUIDE

Oakite Products, Inc.—Booklet F9394 incorporates charts of equipment, cleaning methods, solutions, concentrations, temperatures, cleaning equipment. It covers cleaning, descaling, derusting, paint stripping, rust prevention, sanitizing, treatment of water in humidifying, air conditioning, refrigerating units. Steam and hot spray cleaning devices are described.

171 DIMINUTIVE DRAFT GAGES

Ellison Draft Gage Co.—Bulletin 215 describes the new line of Minified straight-line diaphragm actuated draft gages, which are about one-half the size of standard draft gages. Designed for use on compact console, graphic, or other power plant instrument panels where space is limited.

172 COUPLING LINK

Columbus McKinnon Chain Corp.—Bulletin 120 covers a new coupling link that enables alloy chain users to make their own sling and special assemblies. The link, which can be assembled in a few seconds, consists of a pair of body halves, a tubular stud and a hardened alloy steel pin.

173 ELECTRICAL PRECIPITATORS

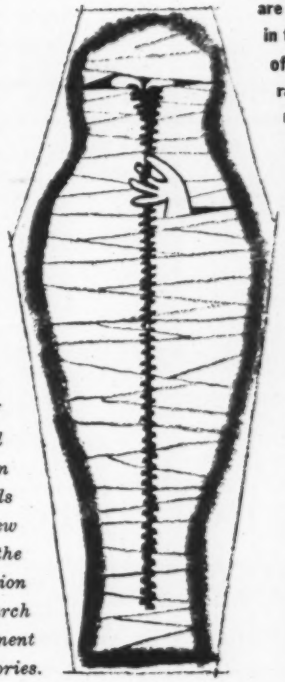
Research-Cottrell, Inc.—Illustrated General Bulletin, 28 pages, describes Cottrell theory, methods, types, and specific applications in a variety of industries, including power, steel, chemical paper, metallurgical, gas, oil, and carbon black.

75 YEARS

ON THE JOB

INGENIOUS PACKAGING

The most advanced developments in electronics are being made in the sphere of airborne radar and related ground control systems because of military emphasis.



Further applications of electromechanical techniques in these fields are creating new openings in the Systems Division of Hughes Research and Development Laboratories.

Engineers who have demonstrated ingenuity and inventive ability will find interest in areas of work that call for devising reliable, maintainable, manufacturable designs for precision equipment developed at Hughes Research and Development Laboratories. The design of this equipment, manufactured at Hughes, involves mechanical, electromechanical, electronic, microwave and computing problems. Design also requires the use of such advanced techniques as subminiaturization, unitized "plug-in" construction, with emphasis on design for volume production. Knowledge of electronic components, materials, finishes, and military specifications is useful.

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You will set up high temperature test programs to obtain: (1) Mechanical and physical properties, (2) Stress-strain or load-deformation information, and (3) Creep and fatigue data. You will also analyze, evaluate and correlate experimental data, write technical reports, consult with design and structures engineers.

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- *Liberal employee benefit program.*

YOUR *New Catalogs* GUIDE

174 OIL AND GAS BURNERS

Ray Oil Burner Co.—An illustrated 16-page catalog gives specifications and capacities of commercial and industrial oil and combination gas-oil burners. It covers fully automatic, semi-automatic, and manually controlled horizontal rotary oil burners, gas burners, and combination gas-oil burners; commercial and domestic pressure-atomizing types for oil, gas, or combination gas-oil. Tables and other technical data are included to aid in selection.

175 METER TESTING

Hydraulic Products Co.—Bulletin is illustrated with installation photographs of air-water testing of gas meters ranging from five to sixty light by an air-mechanical lifting and depressing device providing multiple loading.

176 FLEXIBLE, SWIVEL, SWING, AND REVOLVING JOINTS

Barco Mfg. Co.—A group of catalogs cover flexible, swivel, swing, and revolving joints for piping and lines conveying steam, oil, air, gasoline, water, chemicals, including corrosive acids and alkalies, and other fluids or gases. Types cover pressures up to 750 psi, steam, and 7500 psi hydraulic. Complete range of sizes. Catalogs No. 215 "Flexible Ball Joints"; No. 265 "Rotary Swivel Joints"; No. 400 "Barco Swing Joints", No. 300 "Revolving Joints" and No. 269 "High Pressure, Hydraulic Swivel Joints."

177 ALUMINUM CASTINGS

Morris Bean & Co.—A booklet on "The Antioch Process" offers a brief technical description of the mold making process developed by Morris Bean and used currently in the production of aluminum castings. Loose specification sheets covering applications of the process in aircraft parts, tire molds, electronics fluid flow and miscellaneous castings are available.

178 DRAWING PENCIL

American Lead Pencil Co.—A technical test kit with 2 Venus drawing pencils is offered free. Lead is homogenized under the patented colloidal process to assure smoothness, no scratching, no hard spots, no soft spots.

179 GEARS, GEAR ASSEMBLIES

Advance Gear & Machine Corp.—Catalog illustrates and explains various types of gear cutting done as well as a representative group of special gears and gear assemblies produced. All types of custom gear cutting and gear assemblies to customers' specifications as well as many assemblies, of their own design are offered by the company.

180 PRESSURE PILOT

Hammel-Dahl Co.—New 12-page Bulletin No. 110 in three colors presents description of performance and operation of a pilot which provides control over a 1 to 100 per cent span of the Bourdon tube range. Reversing action and setting the three control actions—proportional, on-off, or differential gap—are described in detail and illustrated with photographs, tables, schematic sketches, and isometric views. Mounting, dimensions, and Bourdon tube ranges and materials are included.

181 POWER TRANSMISSION EQUIPMENT

Lovejoy Flexible Coupling Co.—Illustrated catalogs cover the following: Flexible Couplings, cushions changed without shutdown, no lubrication needed, 1/4 to 2500 hp. Variable-Speed Pulleys, change speed while motor is running, ratios to 3 to 1, fractional to 15 hp. Select-O-Speed Transmissions, ratios to 10 to 1, fractional to 7 1/2 hp. Universal Joints, precision-ground alloy steel, 13 sizes, bores 1/4 to 2 in., lengths 2 to 10 3/8 in.

A world of facts at your fingertips. Use coupon on page 44 for free catalogs you need.

YOUR *New Catalogs* GUIDE

182 HEATING BOILERS

Erie City Iron Wks.—An eight-page catalog describes welded steel heating boilers, Series 500 for automatic firing, and H-500 for hand firing. Covered are design and construction, cross section views, engineering data and list of representative users over U.S.A.

183 OIL-RETAINING BEARINGS

Bound Brook Oil-Less Bearing Co.—More than 600 of the most widely used sizes of oil-retaining porous bronze bearings are listed in the firm's Stock List No. 4. Also provided is condensed information on application, installation, lubrication and machining.

184 DRAFTING MACHINES, INSTRUMENTS

V. & E. Mfg. Co.—16-page booklet describes and illustrates Vemco drafting machine, plus vertical and detail models and various scales. 20-page booklet covers company's line of drawing instruments and materials.

185 REDUCTORS, RATIOMOTORS

Boston Gear Wks.—A 208-page, pocket-sized catalog contains selection, engineering and ordering information, photos, diagrams and specification and dimension tables for speed reduction units.

186 OIL FILTERS, STRAINERS, OILING DEVICES

Wm. W. Nugent & Co., Inc.—Seven bulletins: No. 6 illustrates and describes Nugent pressure strainers; No. 7 gravity filters; No. 7A pressure filters; No. 8 tanks, pumps, shaft oilers; No. 14 oiling and filtering systems for turbines, paper mills, steel mills, pumps, compressors; No. 15 oiling devices; No. 16 sight feed valves, multiple oilers, flow indicators, sight overflows, and compression union fittings.

187 TOOL STEELS

Firth Sterling, Inc.—A 48-page general catalog illustrates and gives specifications of sintered carbide for standard blanks, standard tools, toolholders and woodworking blanks, and tool steels for highspeed toolholder bits, polished drill rod, ground flat stock, shank steel. A section deals with the company's service, distribution, and quality control.

188 O-RINGS

Linear Inc.—Compact 12-page folder contains tables of standard O-ring sizes as well as dimensional data for installation. Notes contain general recommendations on clearances, design, material, machining, and finishes for most O-ring applications. A special compound bulletin describing the latest polymers and synthetic rubbers from which O-rings can be moulded is also included.

189 PRESSURE TRANSDUCER

Pace Engineering Co.—A data sheet describes magnetic reluctance transducer for gage or differential pressure measurement. Specifications of accuracy, sensitivity, dynamic response, and environment are given along with a discussion of operating principles. Auxiliary equipment for recording and control applications is also described.

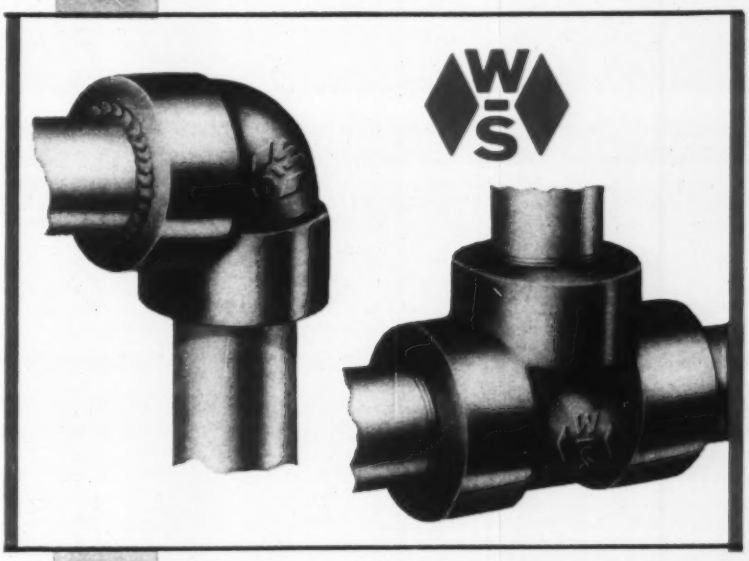
190 STEAM TURBINES

Terry Steam Turbine Co.—Bulletins in looseleaf form which cover a complete description of Terry solid wheel turbines with cross section drawings of typical units for both moderate and high steam pressure conditions: a description of the Terry axial flow impulse, both single stage and multistage; Terry gears which are used for speed increasing and speed reducing.

191 VIBRATING CONVEYORS

Carrier Conveyor Corp.—"Natural-Frequency" vibrating conveyor Bulletin No. 112, 12 pages, describes new application of scientific natural-frequency vibrating principle as applied to Carrier vibrating conveyors with great reduction in power requirements, double capacity, and significant savings in maintenance and down-time costs. Illustrates applications for detergent powder, crushed stone, foundry sand, castings and shakeout, spiral elevating for air cooling and other drying, heating, separating and blending processes; other uses and engineering data.

2 Safe Ways to PROTECT Pressure Piping...



W-S SCREW-END and SOCKET-WELDING FORGED STEEL FITTINGS

Pipe joints are potential trouble spots in high pressure piping systems. Change in direction of flow causes turbulence, erosion and vibration. Watson-Stillman fittings are made to absorb this type of punishment. They're drop-forged for strength and toughness and safety-factor designed for the protection of your piping.

Choose between a welded piping system and a screwed one to suit your needs. Then choose W-S Screw-End or Socket-Welding Fittings to join your pipe. They're available in sizes ⅛" to 4" for piping up to 6000 lb. W.O.G. class. For high temperature or corrosive service you can get W-S Forged Stainless and Alloy Steel Fittings, too. Send today for our informative catalogs.

W-S FITTINGS DIVISION

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*MINIATURE PRECISION BEARINGS, INC.

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LATEST INDUSTRIAL LITERATURE

192 LUBRICATION EQUIPMENT

Universal Lubricating Systems, Inc.—A catalog covers air couplers, ball swivels, buttonhead couplers and fittings, drain plugs, flush type fittings, grease fittings, hose and guns, hose adapters, needle type adapters, swivel couplers.

193 PANEL ENGINEERING

Leeds & Northrup—A 12-page catalog illustrates and describes design and construction of centralized control boards for steam power plants. Application photos are included along with background and photos on the company's facilities for designing and installing control units.

194 VERTICAL TURBINE PUMPS

Johnston Pump Co.—An 8-page catalog illustrates and describes oil and water lubricated vertical turbine pumps. Installation photos are included, along with cutaway photos showing features of both oil and water lubricated units.

195 TIMERS

R. W. Cramer Co.—A 4-page bulletin covers Cramer's line of interval timers, reset timers, duplex-cycle timers, time-delay controllers, cycle timers, percentage timers, running-time meters, reversing motor timers, multi-contact timers, and time totalizers. Features of the synchronous motor used are emphasized.

196 STEAM-GENERATING EQUIPMENT

Kewanee Boiler, Div. American-Standard—The 32-page Kewanee General Catalog 80 gives full description and complete data on entire line of boilers, boiler-burner units, and other equipment for heating, power, or process steam. It includes diagrams of small residential types up to large industrial sizes of 304 hp, for steam or water, high or low pressure, mechanically fired.

197 ALLOY CASTINGS

Curtiss-Wright Corp., Metals Processing Div.—A booklet illustrates and describes processing of stainless steel, Niresist, Nihard, monel, nickel, high chrome and high nickel castings and shows applications of them in melting equipment, molding facilities and in the aeronautical field.

198 ELECTROSTATIC PRECIPITATORS

Koppers Co., Inc., Precipitator Dept.—Brochure describes Koppers electrostatic precipitators in features and performance. Specific operating results are given as well as suggested applications in nuisance elimination, cleaning of process gases, or recovery of valuable products.

199 HOSE ASSEMBLIES

Eastman Pacific Co.—Data sheets illustrate and give specifications on wire braid hydraulic hose assemblies with pressed-on couplings, re-usable couplings, and renewable couplings. Also included are illustrations and data on straight and angled adapter unions and couplings.

200 GAGES

Manning, Maxwell & Moore, Inc.—A 128-page catalog describes the company's line of Duragages, quality, drawn case, chemical, chemical attachments, special application, navy and marine, laboratory and pocket test, Mercury column pressure and vacuum gages.

201 HEAVY DUTY ENGINES

Wisconsin Motor Corp.—Literature describes heavy duty, air-cooled 4-cycle engines: 1 cylinder, 3 to 9 hp; 2 cylinder, 7 to 15 hp; 4 cylinder, 15 to 36 hp. Also available is a folder on the application of the engines to irrigation systems.

202 STEAM PIPING

Pittsburgh Piping & Equipment Co.—A brochure shows the firm's manufacturing, laboratory, engineering and testing facilities for piping for central stations, pulp and paper mills, metal production, chemical processing, atomic energy applications and refineries.

203 GRATING-FLOORING AND TREADS

Irving Subway Grating Co., Inc.—Catalog F-400 contains illustrations, descriptions and engineering data on grating-flooring, treads, and floor armoring (riveted, press-locked, welded types) for industrial and power plants and refinery walkways, stairways, driveways, trucking aisles; ship cat-walks and engine room floors and treads; locomotive, freight and passenger car runways and treads; roadway armoring expansion joints, catch basin covers; bridge decking.

204 DUPLICATING EQUIPMENT

Haloid Co.—A four-page bulletin illustrates and describes the use of Xerography for copying and duplicating drawings, reports, etc., in a large automotive plant.

205 MOTOR REDUCER

Sterling Electric Motors, Inc.—A data sheet illustrates and describes slow speed motor reducers for use where separate motor-reducer combinations are desirable. An eight-page bulletin covers variable speed drives.

206 INDUSTRIAL TIRES

Ohio Rubber Co.—An eight-page bulletin gives sizes and specifications of semi-pneumatic and solid rubber industrial tires, plastic and rubber grips and other molded rubber products.

207 PHOTOCOPY MACHINE

Remington Rand—Booklet P-401 gives detailed information on a machine which makes photocopies of office records in one minute without developing, washing, fixing or drying.

208 PRESSURE REDUCING VALVES

C. E. Squires Co.—A four-page bulletin illustrates and describes the following types of valves: pressure reducing, temperature regulating, combined pressure and temperature regulating, boiler feed water controllers, pump governor, pilot valves.

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Currently we seek men with experience in one or more of the following:

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More and more these days you hear top engineers talk about the many growth opportunities at Melpar. With an increasing number of significant electronic projects, an enlarged staff and facilities, Melpar provides many opportunities for professional growth and advancement. Our new laboratory is an engineer's dream come true; a building conceived by and constructed for the ENGINEER – 265,000 sq. ft. of complete engineering facilities.

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YOUR

New Catalogs GUIDE

209 PIPING PRODUCTS

Midwest Piping Co.—A 192-page bound catalog illustrates and describes welding fittings, forged steel flanges, prefabricated piping, pipe coils. Comprehensive design and application data is included.

210 CHART PAPERS

Technical Charts, Inc.—A bulletin includes 16 different bulletins describing specifications for special recording charts. Subjects of the bulletins include chart paper, special recording papers including heat sensitive and electro sensitive papers, roll chart core sizes, roll chart punch sizes and others.

211 FORCED, INDUCED DRAFT FANS

Green Fuel Economizer Co., Fan Div.—The company offers three bulletins: (1) covering mechanical forced draft and induced draft fans; (2) diffuser fans; (3) the company's Economizers; (4) Fly ash collectors; (5) Industrial air cleaners.

212 BUILDING DRAINAGE CONTROL

J. A. Zurn Mfg. Co.—Bulletin 56-1 covers systems for wall-type plumbing fixtures, roof drains, floor drains, interceptors, cleanouts, high and low pressure hydrants, swimming pool equipment, pipe line strainers.

213 OSCILLOSCOPE CAMERA

Brea Instruments—Data sheet describes high speed oscilloscope camera model OC-1 designed to photograph the signal on a cathode ray oscilloscope screen on a film strip moving uniformly in a direction across that of the signal. Specifications of film, film speed, optics, speed control and accessory reflex camera mount are given, along with a discussion of principles upon which the unit operates.

214 ELECTRIC HEATING UNITS

Edwin L. Wiegand Co.—Catalog 50 covers specifications, construction details, application data, and prices of their complete line of electric heating units. Models are available with strip, ring, tubular, and cartridge heating elements. Also described are immersion, circulation, radiant, and forced-air duct heaters. Charts and tables are provided.

215 TIMING MOTORS

General Electric Co., Telechron Motors—Bulletin IS-140 describes the advantages of Telechron synchronous timing motors and lists specifications of different models. Telechron instrument movements are included. Typical applications are illustrated.

216 DUST-SPOT TESTER

Research Appliance Co.—A four-page folder illustrates and describes Dill dust-spot testers to measure the efficiency of all types of air filters in ventilating systems. It is said to be the first portable instrument commercially available to make rapid determinations at the point of installation.

Read the various items listed . . . one catalog may hold the solution to your present problem . . . select those items of interest to you by number . . . fill in coupon on page 44 and mail promptly.

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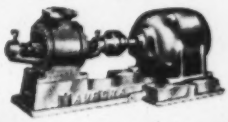
Capacities to 150 G.P.M.



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APCO is the highest development of the Turbine-Type Pump. Unsurpassed for small capacity high head duties. Handles non-lubricating liquids almost indefinitely without wear. Suited to "1001" duties. Write for Bulletin 111 or Condensed Catalog "M".

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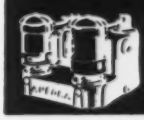

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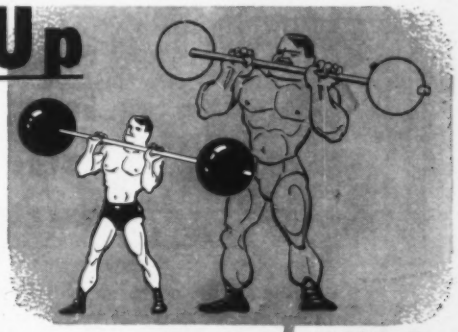
Power-Up your equipment the "Beefless" way



You don't need "beefy" bulk to get brawn . . . nor *size* to insure stamina. Built for the work you want them to do, *sized* to fit your equipment most readily, Wisconsin Heavy-Duty Air-Cooled Engines offer a variety of design and performance advantages.

Every Wisconsin Engine (3 to 36 hp.) has the inbuilt "lug-ability" to slug it out in the roughest company . . . and in this performance, Wisconsin's advanced concept of heavy-duty engineering in a compact power package plays an important role in direct relation to the *design* and *operating* requirements of the original equipment builder.

Bulletin S-188 brings you complete data. Write for it.

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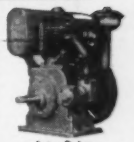
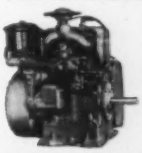


6 to 9 hp.



7 to 15 hp.

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World's Largest Builders of Heavy-Duty Air-Cooled Engines
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YOUR New Catalogs GUIDE

217 CARBON-GRAPHITE

United States Graphite Co., Div. Wickes Corp.—Engineering Handbook GT-55 describes basic characteristics, chemical resistivity, mechanical properties, physical properties, size limitations, suggested tolerances, and operating information for Graphitar (carbongraphite). Suggested methods of assembly and typical applications are also shown. Listing of district representatives and other company products included.

218 BOILER, TANK CONTROL

Commercial Shearing & Stamping Co.—Four catalogs are offered. Catalog P-2 covers products for boiler and tank manufacture; H-7 oil hydraulic fluid power controls—pumps, valves, cylinders, motors; P-3, standard shapes which are available without tool and die charges; G-1, applications and advantages of stampings, forgings and assembled products.

219 SCREW PUMP

Sier-Bath Gear & Pump Co., Inc.—6-page bulletin SE-5 describes the company's external gear and bearing bracket type screw pump for non-lubricating fluids. Viscosity range is 32 SSU to 1,000,000 SSU; capacities 1-100 gpm; discharge pressures 1000 psi for viscous liquids, 500 psi for water. The unit is designed for pumping fuel oils, crude oils, cellulosics, distillates, and water.

220 TUBE BENDING

Boiler Tube Co. of America—A four-page folder shows the company's facilities for bending boiler tubes. Causes of tube failures are illustrated and described.

221 ROTARY ELECTRICAL UNITS

Western Gear Wks., Electric Products Div.—Bulletin 254-A contains specifications and diagrams of the firm's permanent magnet and wound field d-c motors, a-c motors with and without gear reduction, a-c/d-c generators, motor and fan assemblies, axial flow blower assemblies, centrifugal blower assemblies.

222 SPECIAL THREADED PRODUCTS

Cleveland Cap Screw Co.—How specially designed headed and threaded parts are economically produced in production-run quantities by single or double extrusion is described in an illustrated four-page brochure "Specials . . . by Specialists." The brochure illustrates a number of special parts examples and explains various methods of procedure.

223 RUBBER ROLLS

Rodney Hunt Machine Co.—A 60-page handbook contains information concerning every phase of roll manufacture, characteristic, application, operation and maintenance. Included are 34 photographs, drawings and graphs and four tables of data. Also available is a 48-page catalog covering metal, wood and plastic rolls.

224 RIGID METALS

Rigidized Metals Corp.—A folder contains test data on the physical properties of Rigid-Tex metal. Included are flexural rigidity, impact and tensile test results, and sections on rigidity values and crushing strength and sound absorption.

225 VALVES

DeZurik Shower Co.—Catalog describes the line of plug valves and contains an extensive list of recommendations of materials for specific fluids, solutions, suspensions, etc. Advantages of DeZurik valves, including the cylinder-operated valve-positioner, are explained. Specifications for pipe-line strainers, are included.

226 QUICK OPENING DOORS

Struthers Wells Corp.—Bulletin SW-553 covers quick opening doors for processing equipment. Automatic or semi-automatic in operation, the units are available in Ring-lok or Wedg-lok types, designed for vulcanizers, devulcanizers, impregnators, sterilizers, cement block curing vessels, ovens, and creosoting cylinders.

227 PHOTOELASTIC POLARISCOPE

Polarizing Instrument Co.—A catalog describes four new polariscopes and two straining frames for using polaroid light control in industry.

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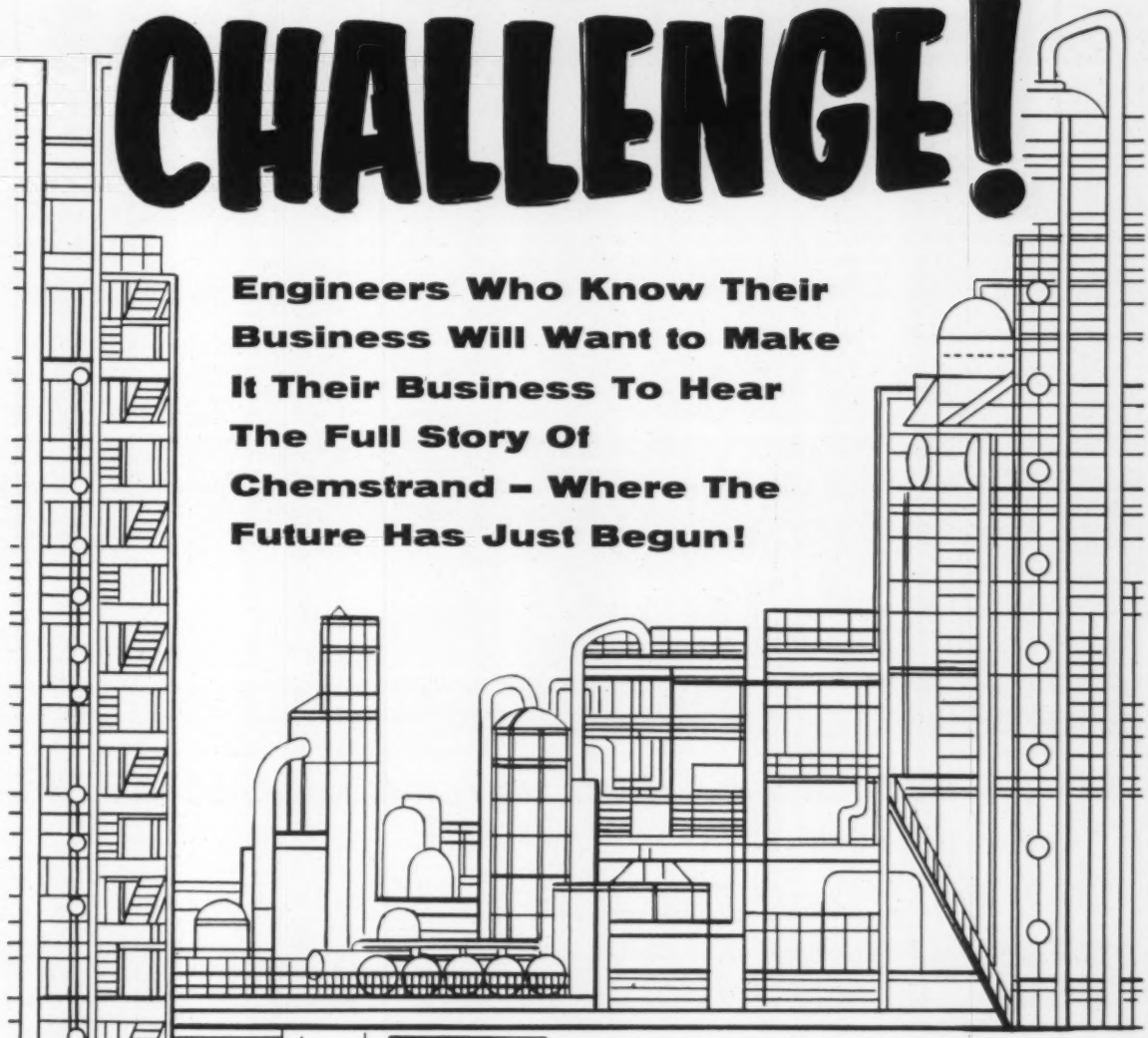
Engineers Who Know Their Business Will Want to Make It Their Business To Hear The Full Story Of Chemstrand – Where The Future Has Just Begun!



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I am a graduate_____engineer.
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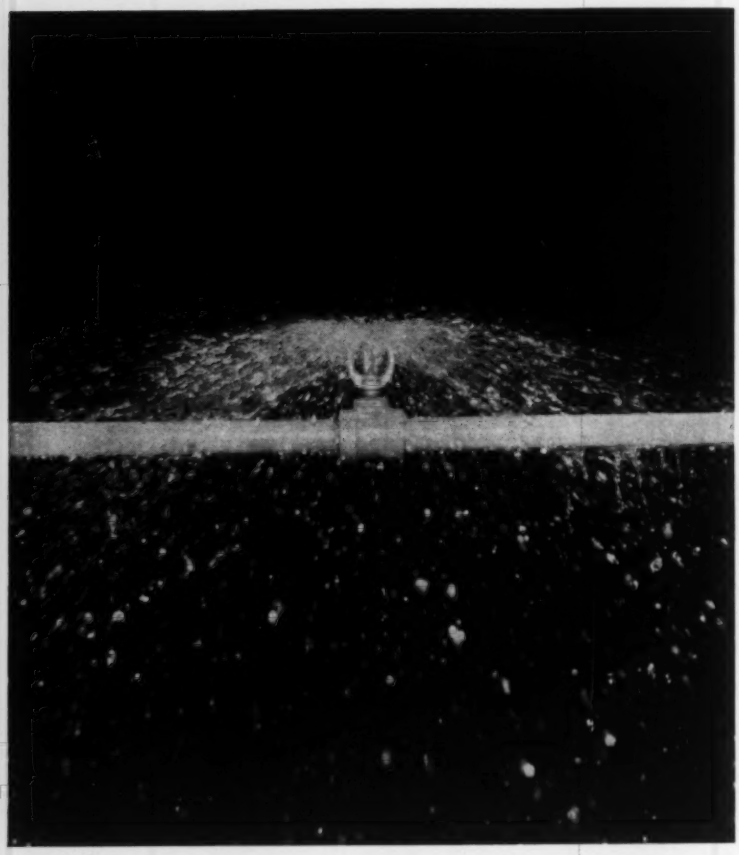

Fire Safety In Action . . .

You're looking at an "Automatic" SPRAY Sprinkler an instant after fire has triggered it into action. The deluge of water will snuff out a blaze before it has a chance to gain headway. Millions of these ingenious devices provide a 24-hour-a-day fire watch in tens of thousands of industrial, commercial and institutional buildings throughout the land.

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For data on SPECIAL HAZARD Fire Protection, write for Bulletin 73.

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YOUR *New Catalogs* GUIDE

228 POLYVINYL PRODUCTS

B. F. Goodrich Chemical Co.—A booklet gives properties and illustrates applications of Geon vinyl resins for industrial and consumer uses in extrusions, film and sheeting, molded products, expanded vinyls, coatings and rigid materials.

229 VARIABLE SPEED DRIVES

Sterling Electric Motors, Inc.—An 8-page bulletin illustrates and describes variable speed drives for metal working, mixing, pumping, materials handling and continuous processing. Engineering, selection and operating data is included. Also available is a revised price sheet.

230 ROLL FORMED SHAPES

Roll Formed Products Co.—A 26-page catalog covers the production of roll formed shapes. Processes shown include notching, punching and cutting to length of special shapes in one continuous operation. Also included are drawings and dimensions of more than 100 simple and complex shapes.

231 PUNCHES AND DIES

T. H. Lewthwaite Machine Co.—New, revised catalog sheets list the range of metal-working punches and dies carried in stock for immediate shipment. Styles to fit most makes of hand-, foot-, and power-operated punch presses are standard. Hand-operated punches, cutters, and benders are also illustrated and described.

232 DIGITAL ELECTRONIC SCALES

Toledo Scale Co.—Literature describes digital electronic scales in which weights are converted to a digital signal at scale and transmitted to any remote location for automatic recording on adding machine, typewriter, card punch, or as illuminated numeral indication.

233 PIPE FITTINGS

Ladish Co.—New 304-page, tabindexed catalog details specification on complete line of controlled quality butt welding fittings, forged ASA, large diameter and TEMA flanges and forged screwed and socket welding fittings. A 56-page technical data section features latest provisions of applicable piping codes and standards to assist in solving piping problems.

234 TEMPERATURE ELEMENTS

Bailey Meter Co.—A six-page product specification, E51-6, describes construction and application of Pyrotron resistance temperature elements and protecting wells, used for temperatures from −400 F to +1200 F. They are available for measurement of single point temperatures, temperature differences, or average temperatures up to 4 points. A chart for selection of correct element and well for any application is included.

235 FUEL CELL FASTENER

Waldes Kohinoor, Inc.—A 7-page catalog provides engineering data and specifications for the company's Waldes positive lock fastener, which is used to hold airplane fuel cells in place without piercing the cell wall on installation. Illustrations and charts explain the use and method of application for the device.

236 CUSTOMIZED MOTORS

Jack & Heintz, Inc.—An eight-page booklet, "Design Your Product To Do a Job—Not to Fit a Motor," covers customized electric motors, and describes the firm's facilities for designing, testing, and producing special electric motors up to and including 2 hp.

237 VALVE SPECIFICATIONS

Cla-Val Co.—Catalog covers a standard line of ASA 125 and 250-lb class valves of the following types: vacuum relief, pressure relief, pressure reducing, pump control, rate of flow controller, check, remote control valves and controls, float solenoid and altitude. Catalog includes design and material specifications and list prices.

238 NAMEPLATE MARKING

Jas. H. Matthews & Co.—An eight-page bulletin illustrates and describes nameplate marking equipment from steel hand stamps to production machines.

YOUR *New Catalogs* GUIDE

239 VIBRATION ISOLATORS

Barry Controls, Inc.—Standard and special mounts for shock, vibration and noise control in airborne, shipboard, and vehicular installations as well as industrial machines are described in 4-page catalog keyed to supply detailed information by reference numbers. Also offers service facilities of representatives for development, test and application of vibration control.

240 FIBERGLASS STRUCTURAL PANELS

Resolite Corp.—New 4-page bulletin on plant daylighting describes translucent panels of fiberglass-reinforced polyester resins manufactured in 11 standard corrugations, including V-beam and flat sheets. Included are specifications, loading, light-transmission values and other characteristics of material, plus detailed drawings of installation methods and photographs of typical installations.

241 SPREADER STOKERS

Hoffman Combustion Engineering Co.—Catalog No. 55-CAD describes and illustrates features of moving-grate spreader stokers. Catalog 55-PDG describes, illustrates, and supplies additional information on spreader stokers with dumping grates. Capacities from 20,000 to 500,000 lb of steam per hr.

242 DRAFTING DESK

General Fireproofing Co.—A folder illustrates and describes a drafting desk which has a belt positioning control and incorporates a reference area and storage space in one compact unit.

243 MECHANICAL-DRIVE TURBINES

General Electric Co.—A line of high-speed mechanical-drive turbines for process industry applications are described in a bulletin, GEA-6232. Special design features as well as application for centrifugal compressor, blower, fans, pumps, and similar equipment are covered in cutaways, schematic drawings, and photos.

244 LAMINATED PLASTICS

Formica Co.—Eight-page illustrated bulletin describes 4-point laminated plastics service which includes application engineering, research, fabricating and customer stock service. Request form 584.

245 VERTICAL PUMPS

Peerless Pump Div., Food Machinery & Chemical Corp.—Bulletin B-505 illustrates and describes the firm's vertical industrial service pumps for application to cooling tower service, tank pumping, line pumping, process and chemical pumping, sump and pit pumping, drainage and dewatering service, booster pumping, recirculation. Bulletin B-148-2 covers propeller and mixed flow pumps for water lift, drainage, irrigation and industrial applications.

246 DUST AND FUME COLLECTORS

Northern Blower Co.—Catalog 1002-6 describes exhaust fans for dust collecting and air handling and includes complete performance tables, test curves, etc. Plans and elevations of typical dust-collecting installations are shown. Separate additional bulletins contain descriptions, dimensions, capacities, etc., of Norblo bag type, hydraulic type, and centrifugal dust collectors.

247 WATER PROCESSING

B-I-F Industries, Inc.—A 24-page color bulletin, B-I-F 6, offers the company's line of Blue Chip quality products for the treatment of water, sewage and waste. Included are meters, feeders and control instruments designed for continuous, accurate and economical operation.

248 SAFETY MARKING TOOLS

M. E. Cunningham Co.—Catalog No. 100, 28 pages, illustrates and describes more than 100 different marking tools and devices. Also included is information on Mecco safety steel, a specially-developed alloy which is said to reduce spalling and mushrooming, and to increase marking life.

249 STEEL TUBING

Bundy Tubing Co.—A 12-page catalog contains technical information on physical properties, available sizes and method of manufacture of steel tubing. Also included are possible applications and methods of fabricating.

... make every step a safe step

BLAW-KNOX ELECTROFORGED® STEEL GRATING and STAIR TREADS

Outdoors or indoors, throughout your plant, you can provide safe walking conditions on catwalks, stair treads, walkways, platforms and floors. For Blaw-Knox Electroforged Steel Grating brings you these exclusive features:

1. rigid one-piece construction—easy to install
2. non-slip twisted crossbar—for safe footing
3. three types of bearing bars
   - square bars—for smoothest walking surface
   - knurled bars (Furro-Grip)—for extra safety plus relatively smooth walking surface
   - serrated bars—for maximum safety under extremely hazardous skid conditions
4. no sharp corners to clog—self-cleaning
5. all surfaces accessible—easy to paint
6. maximum open area—for light and ventilation

Write for your copy of new Bulletin No. 2486
—or send dimensional sketch for quotation.

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Pittsburgh 38, Pennsylvania

GRATING APPLICATIONS: floors • platforms • walkways • catwalks • stair treads • fan guards • shelving • and many other uses, both outdoors and indoors, for versatile steel grating

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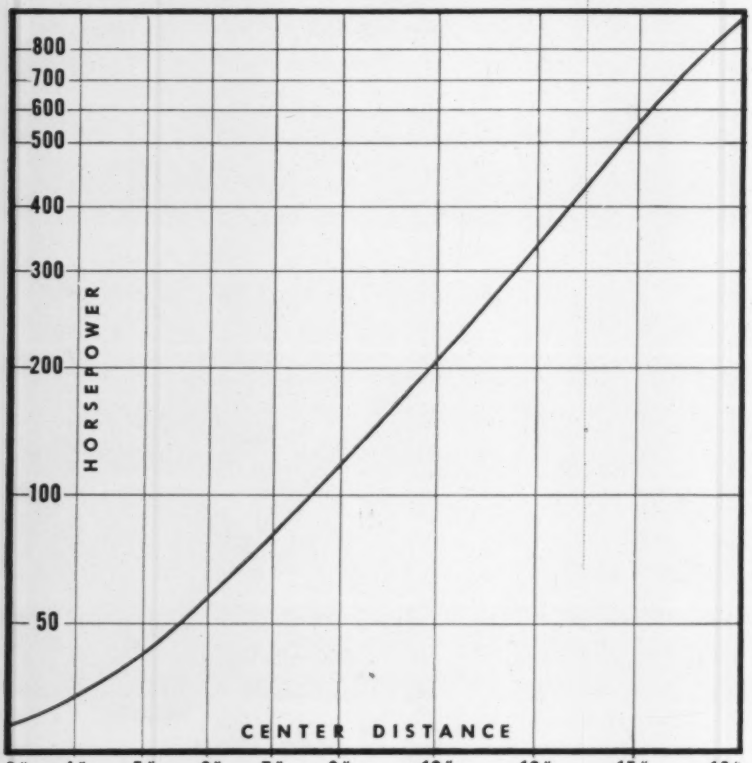

Prove the difference in worm gear speed reducers yourself. Here's how . . .

. . . On this chart we've plotted the mechanical horsepower capacity of Cone-Drive worm gear speed reducers against their center distances. Ratings are for Class I Service with a 5:1 reduction and an input speed of 1750 rpm.

All you have to do is plot the corresponding ratings for the speed reducers you're now using or planning to use. We think you'll be surprised at the results.*

For details on Cone-Drive gearing's double-enveloping design and specifications, ask for Bulletin 600C. We'll send it to you immediately without obligation.

*If you're too busy to "Do-it-yourself", Cone-Drive representatives will be glad to show you filled-in charts.

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YOUR New Catalogs GUIDE

250 PIPING DESIGN

Blaw-Knox Co., Power Piping and Sprinkler Div.—The design of piping for flexibility with Flex-Anal Charts is covered in an 86-page book. It fills the need for the flexibility analysis of any piping system. It is intended for the experienced pipe designer who can, by use of this method and the application of Flex-Anal Charts, accurately analyze most piping systems in a few hours which formerly required days and even weeks. Many tables, Flex-Anal Charts, and typical piping layouts are included.

251 OVERLOAD SIGNALS

W. C. Dillion & Co.—A 6-page folder illustrates and describes overload signals and switches, universal testers, mechanical force gages, dynamometers, thermometers and weight indicators.

252 SLITTING LINES

Yoder Co.—A 76-page booklet provides basic information on design, selection and operations of slitters and slitting lines, including time studies and analysis of operating cycle, discussion of coil handling and scrap disposal methods. Specifications and capacity tables on the firm's uncoilers, slitters, recoilers, coil cars and scrap choppers is included.

253 THREAD INSERTS

Heli-Coil Corp.—Catalog on standard line of screw thread inserts designed for protection and repair of tapped threads in all materials is contained in Bulletin 652-A. Covered are design information, drilling and tapping recommendations, and specifications for various classes of fit. Also available is Bulletin 738 which provides similar details on new screw-lock insert which eliminates the need for lock washers, lock nuts, lock wiring.

254 HYDRAULIC PUMP

Benjamin Lassman & Son—Data sheet describes radial plunger pumps with capacities to 53 gpm and pressures to 3000 psi, continuously rated, for the fluid power source for hydraulic circuits. Information is included on pressure and volume controls.

255 BLACK-ON-WHITE PRINTS

Charles Bruning Co.—"Copyflex Machines and Materials," an 8-page illustrated booklet explains the cost and time-saving advantages of the diazotype direct reproduction process of making black-on-white prints of engineering drawings, as well as faster and cheaper copying procedures for one-writing business systems, such as production control and purchase order receiving.

256 STEAM TRAP PROBLEMS

V. D. Anderson Co.—Bulletin No. 151 entitled "Solving Steam Trap Problems," contains 36 pages of illustrations, drawings, and charts, describing the importance of trap selection and showing application for various industries.

UNITED COMMUNITY CAMPAIGNS

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Idea Sparkers

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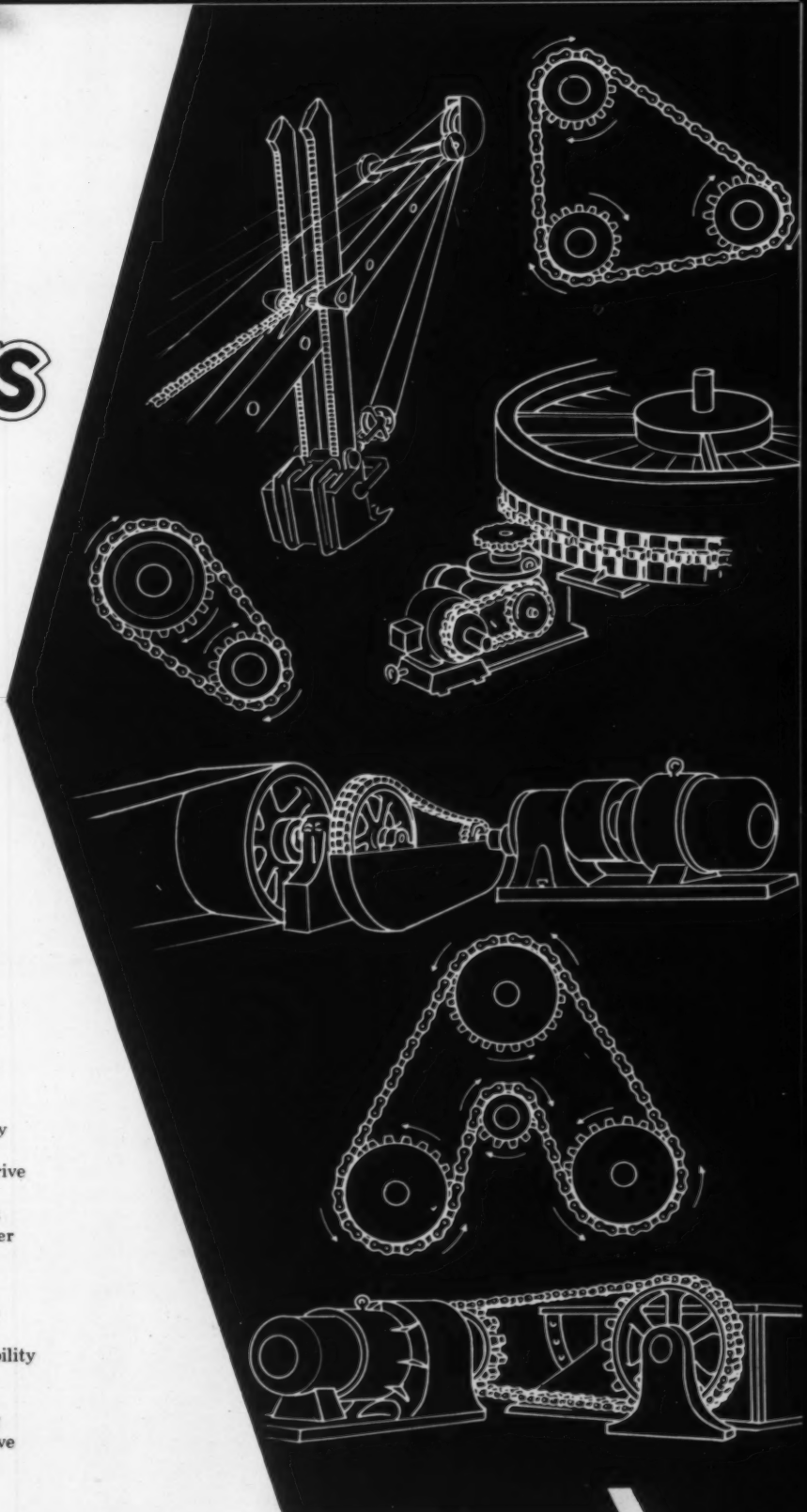
MECHANICAL POWER TRANSMISSION



We wonder, every so often, why many designers seem to take mechanical power transmission mediums for granted — never really try to find a better way of doing it. We're puzzled whether they are really familiar with the many advantages of power chain drives.

So often we see misapplications — gears or belts used when chains are the better choice and vice versa. More important to us, we frequently see the wrong type of chain used — a high speed chain on a slow speed drive . . . a heavy chain on a light load drive. Costly, inefficient applications like this make us wince. Because, after all, there's a *right* chain . . . a *right* size . . . for each application.

Chains have many design advantages . . . so much flexibility . . . that are often overlooked. For example, the ability to resist heat, dust and dirt . . . virtually unlimited choice of center distances . . . space and weight saving advantages . . . offer the imaginative designer almost unlimited opportunity for creative engineering.

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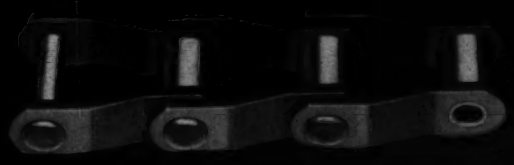
CHAIN BELT COMPANY

LEADERSHIP . . . through creative engineering

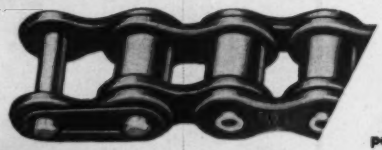
IDEA SPARKERS (CONTINUED)

Next time you have a drive problem, why not take advantage of the design flexibility of power drive chains? Our engineers will be happy to work with you. You'll probably save money, increase efficiency. Just mail the coupon below.

There's a right chain for every drive in the complete CHAIN Belt line



REX CHABELCO STEEL CHAINS . . . rugged, heavy-duty chains for slow to moderate-speed, heavy-load drives. Ideal for operation in exposed conditions . . . built-in clearances permit operation in conditions of dust and dirt. Construction equipment, heavy plant drives, elevators, conveyors, drilling rigs, are typical of the type of service where it outperforms other chains.



REX ASA ROLLER CHAINS . . . precision-built chains for moderate to high-speed drives. Exclusive pitch control system assures longest possible service life. Used for all types of drive service such as agricultural implements, packaging machinery, conveyor drives, lift trucks, drilling rigs, mining machinery, printing machinery and general industrial drive service.

REX OFFSET SIDE BAR ROLLER CHAINS combine the high-speed service features of ASA roller chain with the strength and flexibility of Chabelco Chains. Special "built-in" clearances and alloy-heat-treated pins assure long service life under severe operating conditions. They are especially suited to heavy-load operation under dusty, dirty conditions.

REX LEAF CHAINS. While not properly described as power drive chains, these rugged chains are ideal for tension linkage service . . . counterweight mechanisms, reciprocating motions, load carrying, etc. They are widely used on lift trucks where their construction assures greater ultimate strength for a given chain weight, size and cost than with any other chain.

CHAIN Belt Company
Dept. DP-2
Milwaukee 1, Wis.

☐ Send me informative literature on Rex Drive Chains.
☐ I would like to have a CHAIN Belt District Sales Engineer call.

NAME .....
COMPANY .....
ADDRESS .....
CITY..... ZONE..... STATE.....

These are but a few of the many types of Rex Chains for power drive service. There is a right size and type for any application.

CHAIN BELT COMPANY

MILWAUKEE 1, WISCONSIN

YOUR *New Catalogs* GUIDE

257 BALL THRUST BEARINGS

Gwilliam Co.—Catalog No. 28 describes, illustrates and lists standard sizes of various types of ball thrust bearings, roller thrust bearings, and journal roller bearings.

258 EFFECTS OF CHECK VALVES IN OVERCOMING WATER HAMMER

Williams Gauge Co.—The cause, effect, and control of water hammer in piping systems are considered in an 8-page bulletin. After describing water hammer in nontechnical terms, the brochure indicates its potential damage to piping, instruments, and other parts of water systems, and considers methods of controlling it.

259 BOILER FEED PUMPS

Pacific Pumps, Inc.—Bulletin 122 illustrates and describes boiler feed pumps for high-pressure service. Included are 4-color cutaway photos showing features of the pumps, a performance chart and a discussion of pump design and manufacturing.

260 HELICAL SPRINGS

Union Spring and Mfg. Co.—A 48-page catalog contains engineering data and descriptions of helical springs, Belleville springs, stampings and steel castings from 1 to 7500 lb.

261 LEATHER BELTING

Graton & Knight Co.—A 36-page illustrated catalog and application manual, 101A, "Leather Belting For More Production-Power" has data on power transmission equipment. Industrial leather products include flat, round, link and V-belting; belt cements and dressings; lace-leather and cut belt lacing.

262 WELDING

Lincoln Electric Co.—"Elements of Weldesign" is a series of pamphlets issued periodically to design engineers, production men, and management executives. Current series outlines fundamentals of how to design with steel, to reduce costs and improve performance, with special charts and checking information.

263 ROTATING EQUIPMENT

Eaton Mfg. Co., Dynamatic Div.—A 16-page bulletin describes eddy-current rotating equipment, including couplings, brakes, dynamometers, adjustable speed drives. Basic principles of the equipment are diagrammed and discussed, and torque, heat, cooling, control and operating characteristics are outlined.

264 PRECISION BALL BEARINGS

Marlin-Rockwell Corp.—Form No. 1543 contains listing and dimensional data covering super-precision instrument ball bearings for use in gyros, synchro-motors, aircraft radio and radar equipment, servomechanisms and other instrument applications.

265 MOTOR ROTATION TESTER

James G. Biddle Co.—4-page bulletin No. 80 illustrates, describes and gives operating information on motor and phase rotation tester for determining the direction of rotation of electric motors before they are connected to the line and determining the phase rotation or sequence of energized power circuits.

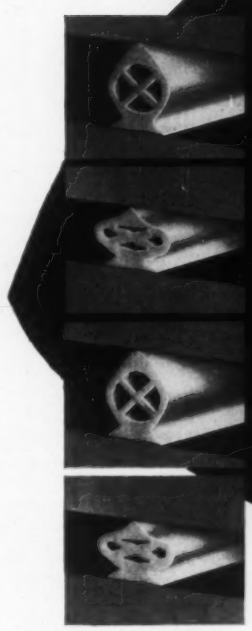
266 A-C MOTORS

Reliance Electric & Engrg. Co.—Bulletin B-2102 is designed to help in selection of both the new and current line of a-c squirrel-cage induction motors for applications from 1 to 200 hp. The selector catalog points out advantages that motors offer in pre-lubricated bearing design, heavier bearing-to-bearing shafts, indestructible pressure-cast rotors, and shock-resistant frames. Construction features selection data, dimensions, prices, and ordering instructions are presented.

267 FLUSH LATCHES

Hartwell Co.—A 44-page catalog describes firm's background and facilities and applications and materials specifications of flush latches and hinges. Diagrams show the various models and installations.

MORE OF THE GARLOCK 2,000



See HOW SILICONE GASKETS FLEX AT −70° F AND +450° F

GARLOCK SILICONE RUBBER PRODUCTS

remain flexible at both high and low temperatures . . . ideal for gasketing on electrical and steam appliances, automotive and aircraft products. Won't stick to metal at high temperatures, either. And, silicone has no odor or taste, will not contaminate or corrode adjacent parts. Let us know your requirements. Garlock is equipped to handle even the most difficult thin wall extrusions.

Extrusions and molded parts of Silicone Rubber are only part of "The Garlock 2,000" . . . two thousand different styles of packings, gaskets, and seals to meet *all* your needs. It's the *only* complete line . . . it's one reason you get unbiased recommendations from your Garlock representative. Call him today or write for Folder AD-147.

THE GARLOCK PACKING COMPANY,
Palmyra, New York

For Prompt Service, *contact one of our 30 sales offices and warehouses throughout the U.S. and Canada.*

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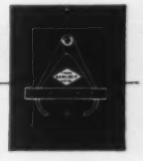


Packings, Gaskets, Oil Seals, Mechanical Seals, Rubber Expansion Joints

TOLERANCES ARE TOLERANCES . . . or are they?

L. A. Edwards

ASST. SALES MGR., THE CINCINNATI GEAR CO.

Our customers' gear specifications call for many different and often critical tolerances . . . say .0002" or .0003" or whatever they may feel is required for their product. Unless asked, we don't question a customer's specifications, but in some cases we've wondered why particularly close tolerances were called for — and if they were worth the *added cost*. We had an occasion to talk to one customer recently about some gears they had us make to .0002" pin size limit. This firm also made some of its own gears. We asked this man if they had any trouble adhering to such strict tolerances and he said yes they did, but if their parts were "close enough" they used them anyway!

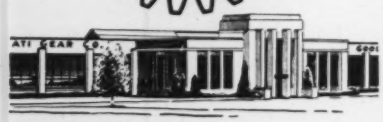
Now, this hardly seems logical — for if his own gears, made to slightly more liberal tolerances, were satisfactory for the job, he could have saved his company some money by being more realistic in his tolerance demands of us. We're not just trying to be philanthropic; it's a purely practical matter for us: unnecessarily critical requirements force us to enter a higher bid and so make our work more expensive than need be. Thus he paid more than necessary for the gears to do his job, and we ran the risk of losing a good customer. That's why we're always happy to see a customer go over his specifications with a sharp pencil.

THE CINCINNATI GEAR CO.

CINCINNATI 27, OHIO

"Gears — Good Gears Only"

CINTI



YOUR *New Catalogs* GUIDE

LATEST INDUSTRIAL LITERATURE

268 LATTICE MOUNTINGS

Lord Mfg. Co.—Bulletin No. 701 gives specifications on lattice mountings to provide flexible support for mechanical equipment subject to intermittent or continuous low frequency, high amplitude vibration.

269 HAND TACHOMETERS

Boulin Instrument Corp.—A 4-page, 2-color illustrated bulletin describes single range and dual and triple range tachometers with a stop button feature. These units indicate speed instantaneously and continuously regardless of the direction of rotation.

270 TAPERED ROLLER BEARINGS

Timken Roller Bearing Co.—An eight-page folder describes the four new tapered roller bearings along with auxiliary parts that have been developed to provide customers with lower cost bearing applications without sacrificing the long life and minimum maintenance expected.

271 ROLLER CHAINS, SPROCKET WHEELS

Link-Belt Co.—Roller chains and sprocket wheels are covered in Book No. 2457. Included in the 148 pages is engineering information on the selection and installation of precision steel roller chain for power transmission and conveyor service. One section contains preselected drives which are available from stock.

272 CHROMIUM

Van der Horst Corp.—A 12-page illustrated brochure describes Porus-Krome, a porous, hard, wear and corrosion resistant chromium designed to increase life of internal combustion engine cylinders and compressor cylinders. Process is used for new equipment and reclamation of power cylinders in the marine, aviation, railroad and oil and gas industry.

273 CELLULAR RUBBER

Great American Industries, Inc., Rubatex Div.—Catalog 2C describes the advantages of Rubatex closed cellular rubber and shows a physical and thermal properties chart. Typical die-cut gaskets and a how-to-order sheet for prospective users desiring a quotation are included.

274 GAGES

Sheffield Corp.—Catalog 126-53 has 24 pages devoted to Sheffield "Pluniet" Gaging Cartridge. Tells how to design and make your own air gaging and machine controls. Gaging ranges .001 to .080, amplification 62.5 to 5000 to 1. Describes a type of gaging cartridge used in conjunction with Sheffield Column and Dial Type Precisionaire Gages and other makes. Can be applied to a wide range of gaging, tooling and fixturing.

275 VALVE OPERATORS

Harvill Corp., Tork-Master Div.—Engineering manual on "push-button" automatic valve operators for remote control of industrial valves up to 125 in. Typical installations and new uses shown. Unique, low-cost installation does not interrupt line-flow or require shut-down for mounting. Patented design gives extra torque for valve opening and closing. Meets all existing specifications.

276 BRONZE BEARINGS

Johnson Bronze Co.—A catalog lists and illustrates more than 900 sizes cast bronze bearings, 400 sizes of bronze bars, cored and solid, graphited bronze, powdered bronze in straight, flanged and self-aligning bearings, bearing babbitt.

277 SHEET METAL STRUCTURES

Lindsay Structure, Inc.—Catalog describes method of using "Pre-Tensed" sheet metal for buildings, rooms, partitions, truck bodies, housings for equipment. Explains principles, assembly method, applications. Diagrams and structure data, tables of weights. Drawings of component parts. Fully illustrated.

278 WROUGHT IRON PIPE

A. M. Byers Co.—A 48-page illustrated catalog covers wrought iron pipe and tubular products. Included are sections on properties, specifications, mill standards, product identification and ordering.

279 STEEL AND ALLOY PLATE FABRICATION

Downingtown Iron Works—Bulletin PF, 12 pages, shows typical pressure vessels, tanks, etc., and fabrications of carbon, stainless, clad, and other ferrous and nonferrous metals and alloys. Towers, columns, converters, evaporators, separators, and heaters are illustrated with dimensions.

280 STEAM VALVE CALCULATOR

Fulton Sylphon Div., Robertshaw-Fulton Controls Co.—A slide rule card shows valve sizes required for heat and pressures of given quantities. The reverse side shows valve size required for given liquid flow. Also included is a guide to measuring the proportional pressure drop-capacity for saturated steam.

281 LOADING ARM

Chiksan Co.—Four-page Bulletin 1055 covers hydraulically controlled marine loading arms and shows operational advantages enabling one man at a remote control point to place flange end of 6, 8 or 10 in. aluminum loading arm aboard largest tanker. It operates from 220/440 v, 3 hp motor, 7.5 gpm hydraulic pump.

282 ELECTRICAL HEATING UNITS

Edwin L. Wiegand Co.—Booklet illustrating and describing 101 ways to apply electric heat and showing approved methods of electrically heating liquids, air, gases, machine parts and process equipment. All items are illustrated and described in detail and varied applications are shown. The heating units go under the trade name of chromolox.

283 ULTRA-VIOLET MICROSCOPE

Norden-Ketay Corp., Boston Electronics Div.—Four-page bulletin No. 370 has description and applications for an ultra-violet microscope which is said to be the newest means for studying the geometry and the chemical similarities and dissimilarities of objects within specimens of various types.

284 STEEL DOORS

Kinnear Mfg. Co.—Bulletin No. 88, 32 pages illustrated, covers steel rolling and other types of Kinnear Doors. One section describes a galvanized-steel sectional overhead-type door that combines durability with operating convenience; facilities for glass light-sections in a door for all types of commercial and industrial service openings are offered. The bulletin gives details, clearance requirements, and available accessories.

285 CHEMICAL PUMPS

Roy E. Roth Co.—Section 100 covers Roth chemical pumps, 21 and 22 series, all single-stage side-suction, end-mounted pumps based on turbine vaned-impeller design and built especially for chemical service. Advantages, applications, construction, and performance are included.

Read carefully . . . select wisely, then send coupon on page 44 now for your free catalogs. Requests limited to 25 catalogs. (Sorry, no catalog distribution can be made by us to Students.)

YOUR *New Catalogs* GUIDE

286 GLASS FIBER INSULATION

L-O-F Glass Fibers Co.—Illustrated brochures outline advantages of both Microlite and superfine glass fiber insulations, low-density, resilient insulating materials with high thermal efficiency and sound absorption characteristics. They are described as being resistant to heat, fire, moisture, and corrosion and the company recommends their use in applications where the greatest thermal and acoustical efficiency is desirable in the smallest space. Tables are included on thermal and acoustical performance.

287 COOLANT CLARIFIER

U. S. Hoffman Machinery Corp.—A four-page bulletin, M-125, describes "Roto-Flo" 15 Magna-Grip coolant clarifier for machine tools working with steel and iron parts. It contains operational data an a cross-section view of the unit, photos of typical installations on machine tools, and a list of complete specifications and features of the unit. The bulletin also contains schematic illustrating dimensions.

288 MOTION CONTROL

General Tire, Industrial Products Div.—Catalog No. 701 illustrates and describes instrument mounts, machinery mounts, bearings, bushings and special types of mounts for eliminating shock, vibration, oscillation, misalignment, noise. Specification tables and diagrams of various types are included.

289 AIR HYDRAULIC PUMPS

Ledeen Mfg. Co.—An eight-page folder illustrates and describes the company's line of air hydraulic pumps and power units for the operation of high pressure cylinders, clamps, valves, actuators. Application layouts, ratings and dimensions are shown.

290 SPECIAL PURPOSE RUBBER

B. F. Goodrich Chemical Co.—A 20-page booklet gives specifications and application data and shows photos of uses of Hycar American rubber in various forms throughout industry. This special purpose material is said to resist oil and solvents, abrasion, aging and high temperatures.

291 LIQUID METERS

Neptune Meter Co.—New 16-page bulletin describes meters for handling more than 150 industrial liquids in processing, batch mixing, cost control operations. It includes Auto-Stop quantity control meters, Auto-Switch meters which actuate microswitch when desired quantity is delivered, Print-O-Meters which provide meter-printed tickets. Help in selecting proper size and type is given for capacities 2 to 1000 gpm.

292 BOILERS

Brown Fintube Co.—Bulletin No. 554 illustrates and describes the construction, operation, controls of boilers in capacities of from 30 to 350 hp. Dimensions and specifications are tabled.

293 ROLLER CHAINS

Diamond Chain Co., Inc.—Catalog 754 contains information on stock roller chains and sprockets. Selection of stock drives, calculation of chain lengths, installation recommendations, and speed ratio tables are some of the subjects covered in the 64-page catalog.

294 TRACING PAPER

B. K. Elliott Co.—A brochure contains tracing paper samples. The literature relates the advantages and features of Ellco-Vel tracing paper manufactured by the company. It is designed to take as many as five or six erasures over the same place after repenciling and not show "ghosts" at erased spots on blue- or whiteprints.

295 RECORDERS, CONTROLLERS

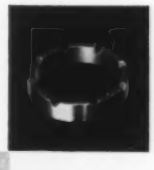
Gotham Instrument Div., American Machine and Metals, Inc.—Catalog 456 offers pressure and temperature recorders, and electric or air operated controllers for continuous, intermittent and batch processes.

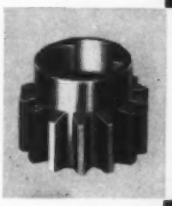
a new expanded field of

BEARING DESIGN and APPLICATION

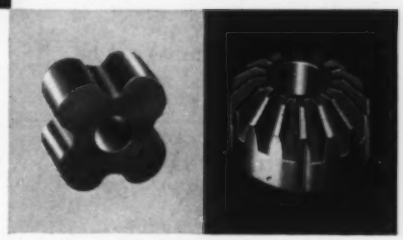
The inauguration of Bunting's new facility for engineering and manufacturing bearings and parts of Sintered Powdered Metals opens a wide new area of opportunity to all mechanical industry.

Sintered Powdered Metal Bearings and parts offer real economies in design. Bunting Engineering and manufacturing skill and traditional technical responsibility assure your most advantageous use of this material.





A competent group of Bunting Sales Engineers in the field and a soundly established Product Engineering Department put at your command, comprehensive data and facts based on wide experience in the designing and use of Cast Bronze and Sintered Powdered Metal Bearings and parts.



Write to our Product Engineering Department in Toledo, or consult our nearest Sales Engineer.

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BUSHINGS, BEARINGS, BARS AND SPECIAL PARTS OF CAST BRONZE AND POWDERED METAL

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EACH PART OF A LOVEJOY UNIVERSAL JOINT IS PRECISION GROUND AND PERFECTLY FITTED

Lovejoy Universal Joints are precision-built for tough service . . . are light-weight, quick-acting to give sensitive response and smooth performance.

Compact construction makes them ideal for close quarter operation. Simplicity of design and absence of complicated parts assure dependability, long life and negligible maintenance.

Lovejoy's full line of standard sizes can provide you with the universal joint that is *just right* for any slow speed application. Special units can be made to individual specifications on request.

Standard sizes range from fractional to 207 hp., diameters ½" to 4", bores ¼" to 2", lengths 2" to 10⅝".

Contact Lovejoy now for complete information. Request bulletin.

LOVEJOY FLEXIBLE COUPLING CO.

4832 W. LAKE STREET • CHICAGO 44, ILLINOIS

Mfrs. of Flexible Couplings, Variable Speed Pulleys and Transmissions, Motor Bases and Universal Joints.

YOUR *New Catalogs* GUIDE

LATEST INDUSTRIAL LITERATURE

296 WOODRUFF KEYS

Standard Horse Nail Corp.—Pamphlet describes woodruff keys, made from cold drawn stock ASA. Illustration in line cuts of sizes. Also mention line of machine keys, taper pins, straight pins, cotter pins and special parts.

297 DRYERS, COOKERS

Standard Steel Corp.—A 4-page bulletin illustrates and describes steam jacketed dryers and cookers. Diagrams and specification tables are included, along with application and operating data.

298 INSULATED PIPING

Ric-Wil, Inc.—A 24-page catalog, No. 55-1, describes prefabricated insulated piping for underground or overhead distribution of steam, oil, hot or chilled water, process liquids; large-diameter prefabricated conduits for housing all utility services; and various related equipment including conduit and pipe testing caps, insulation fittings for 90-deg elbows and unloading slings.

299 ELECTRICAL TIMING EQUIPMENT

A. W. Haydon Co.—A loose-leaf catalog illustrates and gives application and specification data on the company's time delay relays, repeat cycle timers, interval timers, time switches, elapsed time indicators, motor driven counters, chronometric d-c motors, synchronous a-c timing motors.

300 HOT-DIP GALVANIZING

American Hot-Dip Galvanizers Assn.—A 16-page booklet outlines rust prevention in industrial and consumer products through the use of the hot-dip galvanizing process. Included are photographs of products made by the method, and illustrations of production and quality control. A chart compares the method with other types of rust prevention.

301 DEAERATING HEATER

Cochrane Corp.—Bulletin No. 4643 describes a new deaerating heater designed especially for small and medium size power plants. The deaerator is completely self-contained and factory assembled for field installation on a variety of storage tank sizes.

302 KILN GEARS

Falk Corp.—Engineering Report 6171 describes and illustrates the science of manufacturing large precision mill and kiln gears. This report is available to companies that use or manufacture mills of kilns 6 ft or larger in diameter.

303 RINGS, SEALS

Precision Rubber Products Corp.—A catalog illustrates and describes O-rings and a one piece rubber and metal bonded seal for face-to-face sealing. Design, application, dimension and specification data is included.

304 VERTICAL TRANSPORTATION

Otis Elevator Co.—A 28-page catalog provides information on all types of passenger and freight elevators, escalators and dumbwaiters. Application photos, typical layouts and construction diagrams are included.

305 HYDRAULIC PUMPING

Lufkin Foundry & Machine Co.—Bulletin H-2 covers descriptions and specifications of hydraulic long-stroke pumping units for oil well applications.

306 STUD WELDING

Nelson Stud Welding Div., Gregory Industries, Inc.—A manual covers designing, materials, specifications, dimensions and physical properties of the materials used in the Nelweld method of welding studs.

307 HIGH TEMPERATURE WATER GENERATORS

International Boiler Wks. Co.—High temperature water generators are described in a 10-page bulletin, No. 700. Covered are specific features of forced recirculation generators; reasons are given on why high temperature water systems are being selected in preference to high pressure steam systems.

308 FILTERS, FILTER ELEMENTS

Cuno Engineering Corp.—Catalogs cover Micro-Klean replaceable filter elements, of Flo-Klean automatic self-cleaning wire-wound filters, Poro-Klean porous stainless steel media for filtration, and Micro-Klean filters for air line service.

309 RECORDERS

Service Recorder Co.—Catalog No. 10 illustrates and describes Servis recorders for cost and quality control applications in all types of industry. Both mechanical and electrical units are shown.

310 INDUSTRIAL INSULATION

Armstrong Cork Co.—A 32-page illustrated booklet includes specifications for industrial low-temperature and heat insulation. It explains and illustrates insulation products and sundries, and the application of insulation materials −300 F to 2800 F. Design data, standards, and methods of construction are described.

311 AIR COMPRESSORS

Gardner-Denver Co.—An eight-page bulletin illustrates an describes carbon piston horizontal single-stage air compressors for oil-free air in the processing, chemical and plastic industries.

312 OIL, GAS BURNERS

Petro—Catalog 3048 gives 20 pages of information on the selection of equipment, engineering and manufacturing factors, design and construction features, types of controls, and types and ratings of Petro packaged units for oil, gas and combination oil-gas burners.

313 GAS COMPRESSOR VALVES

J. H. H. Voss, Inc.—Bulletin 53-G covers Voss Valves for the replacement of worn or inefficient valves in air, gas, and ammonia compressors. The valves are machined from solid stock and plates are machined and ground; valves and plates are of heat-treated alloy and stainless steel, and are designed to specification to fit the individual compressor for which they are manufactured.

314 ANALOG-DIGITAL CONVERTER

Librascope, Inc.—A six-page folder shows specifications and illustrations of converters which transfer data from shaft to code disks where nonambiguous double brush pick-offs direct it to scan a network. Models cover 7 to 19 digits.

315 CONTROLLED-AIR-DEVICES

Bellows Co.—Bulletins BM-25 and ML-3 illustrate and explain air motors and the choice of built-in valves and auxiliary hydraulic controls available for them. Bulletin ML-3 also describes the basic types of complete-work-units, such as power feeds, work feed tables, drilling units. Both booklets contain application photographs.

316 SELF-ALIGNING COUPLINGS

Koppers Co., Inc., Fast's Coupling Dept.—Six-page folder on Fast's self-aligning couplings gives graphic illustrations of principles and features of these couplings; table of utility factors for various kinds of connected machines; and tables of rating for standard forged-steel couplings and heavy-duty-type couplings.

317 AUTOMATIC COMBUSTION SYSTEM

Preferred Utilities Mfg. Corp.—Bulletin 185 describes "Thermopak" engineered, factory assembled, completely automatic oil, gas or combination fuel, packaged system for installation in existing industrial and commercial boilers. Includes plans and specifications of fuel piping, electrical layout, combustion chamber, and the complete burner equipment and controls on steel base.

318 MATERIALS HANDLING

Syntron Co.—A condensed catalog, No. 5510 contains 50 pages of technical data, brief description and photographs of vibratory equipment, feeders, conveyors, power tools, shaft seals, diesel pile hammers, gasoline hammers, selenium rectifiers and other materials handling equipment.

YOUR *New Catalogs* GUIDE

319 BORE INSPECTION

American Cystoscope Makers, Inc.—The borescope, a precision optical instrument for visual inspection of internal surfaces such as bores, deep holes, and recesses, is the subject of a comprehensive catalog, "ACMI Borescopes."

320 HEAT EXCHANGERS

Griscom-Russell Co.—Bulletin 1401 describes the twin G-Fin section heat exchanger, with longitudinally finned tubes for maximum heat transfer between dissimilar fluids, and for use on heating, cooling and condensing services. Design details, representative installations, complete specifications and dimensions are included.

321 PIPE COUPLINGS

Dresser Mfg. Div.—A 44-page catalog, 531, contains descriptive material, illustrations and engineering data on flexible couplings for joining pipe from 3/4 to 72 in. and up in size. Applications are listed and illustrated for waterworks, sewage, oil, industrial, gas, chemical and other fields. Also included is information on pipe fittings, pipe repair clamps and sleeves, service saddles, expansion joints and other products.

322 FUME SCRUBBERS

Schutte and Koerting Co.—Bulletin 4-R contains technical details on fume scrubbers and "packaged" scrubbing systems. This equipment employs water or other suitable liquid as the scrubbing agent for the control of fumes or dust and is adaptable for the handling of solid particles, liquid particles, or gases.

323 INSTRUMENTS

Consolidated Electrodynamics Corp.—A 12-page general catalog describes data processing instruments and systems for automatic measurement and recording of physical variables, such as pressure, vibration, acceleration, stress, strain and temperature. Systems are designed to record up to 50 high-speed physical variables simultaneously. All instruments are described briefly and specific technical bulletins are listed on each.

324 FLUID CONTROL

Republic Mfg. Co.—Bulletin No. 755 illustrates, describes, and gives general technical data on entire line of fluid control valves of many types, up to 2 in. pipe size, including plug type, with either metal or Teflon plug; 6000 psi selector, needle, globe, and relief valves. Also, bleeders, gage protectors, strainers, and other items are listed. Examples of custom-built units made in small or large quantities to customers' specifications are shown.

325 ADJUSTABLE SPEED DRIVES

General Electric Co.—Bulletin GEA-6127, Speed Variator, describes design, construction, operation and application of a 1-200 hp line of adjustable-voltage d-c drives. Points out low-cost installation, easy maintenance and quality performance features that help increase production and improve processing.

326 SOCKET SCREWS

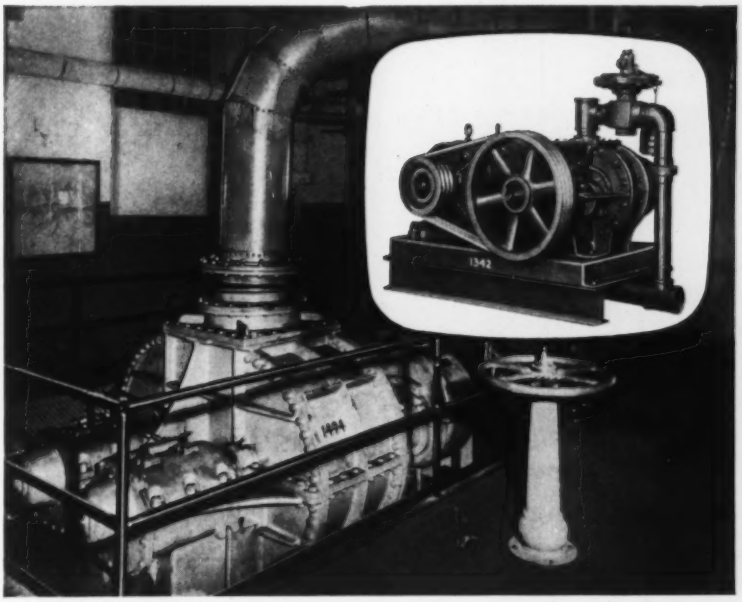
Allen Mfg. Co.—General catalog, G-56, 40 pages, describes the line of hex socket screws and precision fasteners, including flat and button head cap screws, shoulder screws, pipe plugs, dowel pins, Allenuts, and hex keys. Included are engineering data and standards pertaining to socket screws.

327 ALUMINUM HEAT EXCHANGER TUBES

Aluminum Co. of America—Illustrated catalog contains relevant data on Alcoa aluminum heat exchanger tubes. Covers advantages, fabrication, application in petroleum and petrochemical industries, chemical, steam, atmospheric, air and gas. Also use of aluminum alloys, fluid flow characteristics, heat transfer characteristics, specifications and data with tables.

328 TANK CONTENTS INDICATOR

Liquidometer Corp.—Bulletin 532 describes Model 216 remote reading automatic tank contents indicator. This bulletin contains complete mounting dimensions as well as a full size illustration of the indicator which, although occupying a panel space of only 3 × 10 in., has a scale length of 20 in.



ALL SIZES OF R-C GAS PUMPS INCLUDE *plur-ability* VALUES

Positive control of volume and pressure, with the simple rotary impeller principle, stands out as one of the most valuable advantages of Roots-Connersville Gas Pumps. They deliver this prime essential, whether at a trickle of 5 cfm or an outpouring of 50,000 cfm.

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YOUR *New Catalogs* GUIDE

LATEST INDUSTRIAL LITERATURE

329 DRAFTING MACHINES

Charles Bruning Co.—"The Finest in Drafting Machines," a 20-page illustrated booklet, explains the cost and time-saving advantages offered by drafting machines in mechanical drawing, and describes and illustrates models and construction features. A list of available scales is included.

330 SELF-CENTERING ROLLS

United States Steel Corp.—A 20-page illustrated booklet discusses self-centering rolls for processing metal strip. Cutaway photos show the construction and use of divided and grooved rubber-covered rolls, and a case history of their use at the company's Gary, Ind. plant is illustrated and described.

331 LUBRICANT DATA

Fiske Bros. Refining Co., Lubriplate Div.—1956 edition of The Lubriplate Data Book to all who are interested in subject of proper lubrication of all types of machinery. This new Data Book is $8\frac{1}{2} \times 11$ in. in size and contains 36 pages of valuable data pertaining to improvement of machine operation, reduction of power consumption and lowest possible maintenance costs through the use of specialized time tested lubricants.

332 SOLENOID VALVES

Barksdale Valves—Solenoid operated Crescent valves are covered in catalog 5-C. Included are air, four-way and three-way, to 150 psi; air, light oil and water, four-way, three-way, dual pressure, to 150 psi. Information on JIC sub-base mounting is given.

333 MOTION PICTURE CAMERAS

Wollensak Optical Co.—A booklet explaining high-speed photography, its application and the results obtainable and a folder describing the operation and uses of the Fastax high-speed motion picture-oscillographic camera are available. These cameras, used in research, design, commercial engineering, are a continuous moving film type with rotating prism positioned between the lens and the sprocket. They are available in 8, 16 and 35 mm in both 100 and 400 ft capacity and are capable of taking pictures at rates of 150 to 16,000 frames per sec.

334 STREAMLINED BAFFLES

Engineer Co.—Bulletin BW-54 shows the design and describes the construction of streamlined baffles for many types of water tube boilers for various furnace designs and methods of firing.

335 PRESSURE GAGES

American Chain & Cable Co., Helicoid Gage Div.—The 24-page Helicoid gage catalog describes the Helicoid gage as guaranteed accurate to within $\frac{1}{2}$ of 1 per cent of the total dial graduation over the upper 95 per cent of the 270-deg dial arc. Cutaway photographs and line drawings show the complete line of Helicoid gages.

336 HYDRO-MECHANICAL DEVICES

Pathon Mfg. Co.—Bulletin No. 22, 32 pages, illustrates and describes oil hydraulic cylinders and valves. Included are diagrams and dimension tables covering cylinders, connecting eyes, mounting brackets, rams and valves.

337 MULTI-V DRIVES

Worthington Corp.—A 100-page master engineering manual presents a scientific and simplified method for rating V belts. Tables on drive selection contain nearly every possible stock sheave combination. Information on products and range of stock size sheaves with bore limitations is included.

338 RUBBER COMPONENTS

Goshen Rubber Co.—An eight-page brochure describes the company's facilities for producing custom-made rubber parts and components. Laboratory facilities, fabricating techniques and representative products are illustrated.

339 VALVES

Ohio Injector Co.—Seven brochures describe the company's valves. Form 195, redesigned forged steel gate valve line; Form 1000, iron body valves for paper industry; Form 1001, interchangeability of union bonnet bronze globe valves; Form 1002, gate, globe, angle and check valves designed for LPG industry; Form 1008 features redesigned lubricated plug valve; Form 1005, industrial line of iron body gate valves; Form 1006 introduces new line of union bonnet bronze gate valves, also valve comparison chart is available.

340 BLUEPRINT PENCILS

American Lead Pencil Co.—Sampler with free blueprint pencils is offered to engineers, architects and draftsmen. The pencils are especially compounded for outstanding brilliant opaque marking on coarse paper. The company recommends this chemically treated lead for exacting work where a brilliant insoluble and contrasting colored mark is required. It will not be destroyed by sunlight, grease, oil or excessive wetting.

341 BALL BEARING SWIVEL JOINTS

Chiksan Co.—A new 32-page catalog, G-4, covers the company's line of ball-bearing swivel joints, loading racks, manifolding lines, all-metal marine and barge hose, and flexible aircraft assemblies. Typical industrial applications are illustrated and dimensional and operating data is provided.

342 LIMIT SWITCHES

National Acme Co.—Bulletin EM-51 covers the firm's line of heavy duty limit switches designed to meet severe mechanical and electrical conditions imposed by heavy duty machine tools. EM-5512 illustrates a new single pole, double make, double break snap-action series of switches and EM-5524 illustrates a double pole, double throw, quick make-quick break series.

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Large 4-Cylinder Compressors—Up to 700 Hp

YOUR

New Catalogs

LATEST INDUSTRIAL LITERATURE GUIDE

343 DEAERATORS, VALVES

American Water Softener Co.—Booklet 402 illustrates and describes the firm's line of tray type deaerators. Booklet 801 covers hot process softeners, hot Zeolite softeners, deaerating hot process softeners and associated accessories. Bulletin 600 describes the function, operation, design and construction of a balanced piston, single-seated, single control valve for ion exchange cycles.

344 PACKINGS, OIL SEALS

International Packings Corp.—Revised 60-page illustrated catalog and manual 201B covers all types of leather and synthetic rubber packings for hydraulic and pneumatic applications. Information on types, applications and dimensional data of cups, flanges, U and V packings, custom-engineered oil seals, O-rings and other precision molded products.

345 BRONZE PRODUCTS

American Crucible Products Co.—A 12-page bulletin illustrates and describes the company's engineering service plant and laboratory facilities and discusses bronze bushings, bearings, bar stock and babbit metal. Technical data and application photos are included.

346 FLEXIBLE COUPLINGS

Poole Foundry & Machine Co.—A 136-page manual illustrates, describes and gives engineering specification and lubrication data on flexible couplings.

347 EXPANSION COMPENSATORS

Flexonics Corp.—Bulletin AIA No. 30-C22 illustrates and describes expansion compensators for steam and hot water lines. Included is data on a high pressure type to 150 psi and a low pressure type to 40 psi.

348 INVESTMENT CASTINGS

Precision Metalsmiths, Inc.—An 11 × 17 in. chart covers stainless, low alloy and tool steels, nickel alloys, copper base alloys and aluminum alloys. Data listed includes chemical analysis, mechanical properties, castability, machineability, corrosion resistance, weldability, response to plating and heat treating and magnetic properties.

349 FEEDWATER HEATERS, EVAPORATORS

Alco Products, Inc.—Two companion publications totalling 20 pages of technical data and detailed cutaway wash drawings show design and operation of feedwater heaters and evaporators for conventional or nuclear power plants. Feedwater Heater bulletin contains treatise on "Economics of Feedwater Heater Design and Construction," including cost data and installation practices, plus description of Type "D" high-pressure closure. Evaporator bulletin gives concise account of patented automatic thermo-mechanical descaling feature and illustrates six recent installations in large power plants.

350 OIL SEALS

National Motor Bearing Co.—Oil seal catalog illustrates complete line, gives types and sizes of leather and synthetic rubber oil seals, synthetic seals with metal or rubber covered outside diameters, contains design suggestions, drafting information, application data, and installation tips.

351 GRATING, STAIR TREADS

Dravo Corp., Machinery Div.—Bulletin 1105 illustrates and describes aluminum, diagonal, radial, rectangular and serrated grating, stair treads, and special metals, fasteners and construction of these units for industry. Selection and application information is included.

352 POWDER METALLURGY

Chrysler Corp., Amplex Div.—A 52-page treatise, illustrated with photos, tables, charts and graphs, discusses powder metallurgy. Additional material is presented in the form of case histories. Sections are devoted to bearings, component parts and filters.

353 SERVOMECHANISM GEAR BOX

Link Aviation, Inc.—An 8-page bulletin describes the Link Hi-Precision gear box, designed for use in quality computer, servomechanism and testing equipment. Adapters and couplings are also described. The gear box is available in ratios from 10:1 to 3125:1. Size is 3½ × 3½ × 2⅞ in., for all ratios.

354 SELF-ALIGNING ROD END BEARINGS

Southwest Products Co.—Catalog No. 2551, 4 pages, describes "Scref" and "Screm" self-aligning "Monoball" type rod end bearings. Details prints and tells capacities and specifications. Bearings allow the shaft, bolt or pin which passes through the ball to align itself in any direction without strain.

355 PRESSURE GAGES

Norden-Ketay Corp., Instrument and Systems Div.—Four-page bulletin No. 364 has specifications of the Acragage series of gages for measurement of pressure and vacuum. Gages are offered in flush and surface mounting in ranges from 0-15 to 0-20,000 psi.

356 MATERIALS HANDLING

Jeffrey Mfg. Co.—Catalog No. 860 describes experience covering nearly three-quarters of a century, studying handling and processing problems of industry and designing and manufacturing machinery to meet them. The results of service to many types of industries are embodied in this catalog. Describes full line of conveyors, feeders, gravimetric weighers, crushers, shredders, barrel packers, coolers, dryers, magnetic separators, screens, transmission machinery, elevators, power scoops, electronic controls, bin level indicators, rotary bin check valves, car pullers, chains and sprockets.

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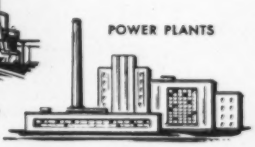

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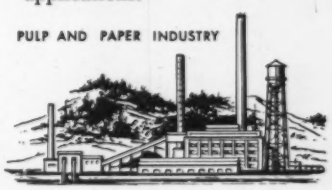

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YOUR *New Catalogs* GUIDE

357 AUTOMATIC VALVES

A. W. Cash Valve Mfg. Corp.—60-page catalog describes and illustrates line of pressure reducing and regulating valves, relief valves, back pressure valves, vacuum regulators and vacuum breakers, differential pressure regulators, strainers, and diaphragm operated control valves. Contains 16 new items not previously included in former catalogs.

358 PROTECTIVE COATINGS

Koppers Co.—Eight product bulletins and two technical data sheets are offered. One bulletin is an application manual for Bitumastic coatings. Others deal with specific product information on individual types of coatings and on aluminum paint and a new cork mastic.

359 RING-LOCKED FASTENERS

Rosan, Inc.—Latest edition of 44-page catalog describes and illustrates patented Rosan locking principle. It shows applications, installation and removal procedures, and furnishes design data and dimensions necessary to select and use ring-locked inserts, studs and other threaded fasteners.

360 PULVERIZER

Kennedy Van Saun Mfg. & Eng. Corp.—Bulletin 44-C describes the Kennedy air-swept ball tube pulverizer, which does fine grinding of all materials including coal at capacities up to 80 tons per hour, availability nearly 100 per cent. Moisture is evaporated in the mill during pulverization. No magnetic separator is employed and low maintenance is guaranteed according to the manufacturer.

361 STAINLESS STEEL

Crucible Steel Co. of America—A 20-page booklet is offered as a guide to future uses of stainless steel in architecture and building. Properties of the material and data on various shapes are included.

362 VERTICAL SHAFT PUMPS

Nagle Pumps, Inc.—Form CW-OC describes the company's vertical shaft pump said to feature simplicity of design, ease of installation, no submerged bearings and wide range of settings, sizes and capacities. The unit designed for handling abrasive or corrosive liquids, heavily laden liquids or hot liquids, available with wide choice of materials.

363 MATERIALS HANDLING EQUIPMENT

Allen-Sherman-Hoff Co.—Data sheets on hydraulic and pneumatic materials handling systems and components describe and illustrate application, design and construction, operation, dimensions (for components) and typical arrangements. Engineering charts and technical data are also included.

364 PUNCH PRESSES

Kenco Mfg. Co.—A 4-page bulletin illustrates and describes 1½ to 15-ton punch presses. A cutaway photo shows individual features of the presses.

365 HIGH PRESSURE COMPRESSORS

Norwalk Co., Inc.—Catalog No. 44 illustrates and describes multi-stage high pressure air and gas compressors. Included are single and two stage compressors, three stage compressors, semi-portable compressors, four stage, five stage and six stage compressors, boosters and special compressors, vertical compressors, conversion tables and installations.

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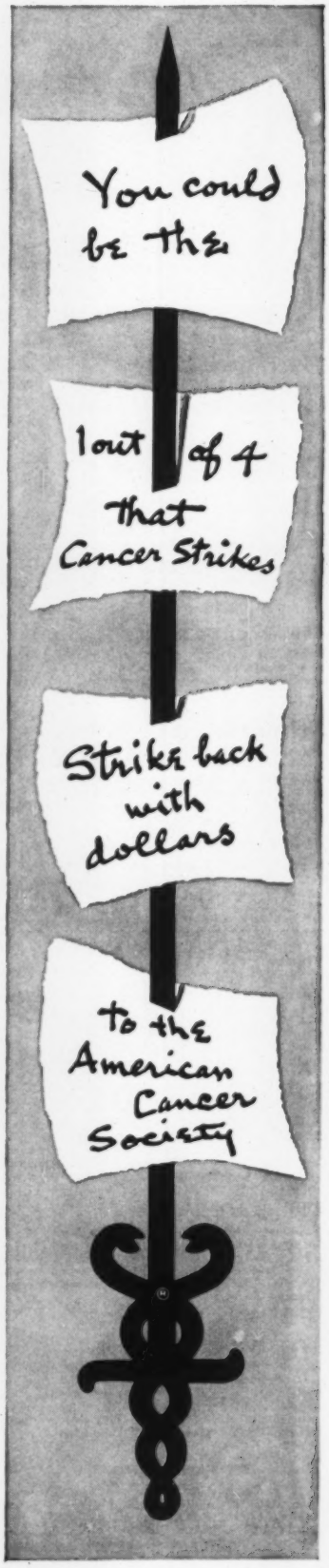

YOUR

New Catalogs GUIDE

366 LPD STRAINERS

J. A. Zurn Mfg. Co.—Several types of LPD (Low Pressure-Drop) Strainers for all purposes and ranging in sizes from ½ to 24 in. are described and illustrated in this 16-page Data Manual No. 952. It carries information concerning the factors to be considered in selecting strainers for a specific application, and the effect of flow rate, screen loading, and the viscosity of fluid on pressure drop.

367 CAST, FORGED VALVES

Edward Valves, Inc.—Condensed catalog 105 contains data on cast and forged steel valves for a variety of applications in boiler rooms, petroleum service, industrial and technological plants. Included are Rockwell-built Mudwonder mudline valves designed primarily for mudlines in oil fields but also suitable for abrasive fluid application in industry.

368 GASKETS, METAL RASCHIG RINGS

Metallo Gasket Co.—Bulletin No. 53 describes metal and metal combined with soft packing for use on high and low pressure service, metal tower packing made as Raschig and Lessig rings. Also included are washers, shims, and metal asbestos valve disks.

369 CONTROL INSTRUMENTS

Consolidated Electrodynamics Corp.—A 12-page catalog illustrates and describes the company's analytical mass spectrometer, leak detector, isotope-ratio mass spectrometer, dual-purpose mass spectrometer, micromanometer, process-monitor mass spectrometer, titrilog, spectrosadic, analytical service. Another booklet contains case histories of the firm's instruments in various industries, and another outlines the company's Systems Div. services in dynamic and static testing, chemical analysis, process monitoring and control.

370 MANUALLY-OPERATED CHUCKS

Cushman Chuck Co.—Catalog 65–1954 contains engineering data and prices on light-, medium-, and heavy-duty, independent, self-centering, and combination chucks, recommended for engine, toolroom, manufacturing, and turret and automatic lathes. It is indexed.

371 FIXED TYPE GAGES

Sheffield Corp.—Catalog LTG-54, 148 pages, is composed of six sections covering the company's standard fixed type gages. A complete engineering manual for gage designers and users is included in the catalog.

372 SPEED REDUCERS

Falk Corp.—Report 550307 shows how the owners of a 6-kiln aggregate plant were able to stabilize kiln production through the use of modern speed reducers and torsionally resilient shaft couplings.

373 DRAWING INKS

Higgins Ink Co.—A brochure describes the firm's line of drawing inks, India inks, waterproof colored inks, art books, accessories, pen cleaner and ink assortments. Also included is a section on how to dilute inks.

374 CENTRIFUGAL PUMPS

Pacific Pumps, Inc.—"The Choice, Design, Characteristics, and Maintenance of Centrifugal Pumps" is a reprint in booklet form of three published articles.

375 CEILING AIR DIFFUSER

Connor Engineering Corp.—Bulletin K-34 describes Kno-Draft type ABC air diffusers and gives dimension and performance tables for selection. Diffuser features built-in anti-smudge cone, sleeve-type dampering and exclusive snap-lock assembly. Single high induction air stream results in rapid and draftless mixing of supply and room air. Minimum overall depth provides a snug fit even where there is little or no space between duct and ceiling.

376 FLEXIBLE COUPLINGS

Thomas Flexible Coupling Co.—A data sheet describes tiny power couplings designed for electronics and other miniature devices.

Engineering News from Bridgeport Thermostat

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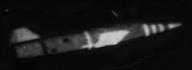

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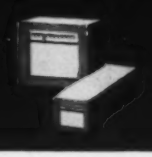

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377 BOILERS, BURNERS

Cleaver-Brooks Co.—Five bulletins are offered. AD-145 covers the company's boiler, 125 to 150 hp, 15 to 150 lb steam, 30 lb hot water for commercial, industrial and institutional use; AD-135 covers a similar unit for 50 through 100 hp; AD-134, for 15 through 40 hp; AD-137, for 125 through 600 hp, 15 to 250 psi; AD-102 covers five burners from 1 to 5 gal to 8 to 60 gal for commercial and industrial use.

378 REGULATING VALVES

Atlas Valve Co.—Condensed Catalog 56C describes broad line of temperature and pressure actuated control and relief valves and governors for power, marine, chemical process, petroleum and related industries. Design makes use of alloys and packing materials to provide long life, rugged and sensitive controls.

379 SPEED REDUCERS

Western Gear Works—Bulletin 5402 covers the company's herringbone speed reducers. Dimensional information is tabled and diagrammed, and specifications, ratios and performance data is included.

380 VACUUM FOR INDUSTRY

Spencer Turbine Co.—Bulletin No. 155, 12 pages, on vacuum for industry contains complete descriptions of stationary and portable vacuum equipment. New features include a table for the rough calculation of the horsepower required for any specific job, and outline of the latest methods of automatic and hand dumping of refuse, a section on the application of vacuum to machine design, and illustrations of the special vacuum tools used in industry.

381 ALUMINUM PIPE, FITTINGS

Aluminum Co. of America—A 16-page booklet covers process piping, pipelines, portable piping, structural piping applications, fittings and flanges, installation, dimensions and weights of aluminum pipe and fittings.

382 GAGES AND THERMOMETERS

Marsh Instrument Co.—Catalogs No. 76-G and 76-T describe in detail a wide line of industrial gages and thermometers. The catalogs are fully illustrated, including cut-away photographs and enlargements of internal parts. They cover also gage accessories, specifications including line drawings and dimensional tables, and templates covering every size and pattern.

383 GAS, OIL BURNERS

Engineer Co.—Bulletin OB-53 illustrates different types and sizes of gas and oil burners and includes engineering data and specifications for pumping and heating sets for all types of liquid fuels.

384 SCREW PUMPS

Warren Steam Pump Co.—Twelve-page, two-color Bulletin S205 is devoted to Standard Gear-in-Head, High-Pressure Long-Body Gear-in-Head and Standard Vertical Gear-in-Head types of Warren-Quimby Screw Pumps. Basic construction and design are discussed in detail and there are sectional views with indicated features; also external and installation illustrations, dimensions, and specifications. Bulletin S206 includes comparable information as applied to Double External Bearing and Hopper types of Warren-Quimby Screw Pumps.

385 COAL VALVES

Stock Equipment Co.—An 8-page bulletin contains descriptive and dimensional data on a redesigned coal valve featuring self-cleaning racks and pinions, strong steel U-shaped gate and large ball bearing equipped gate supporting rollers. The valve is dust-tight. The gate offers lap closure on four sides and is well suited for applications in chemical processes, cement plants and other industries in addition to power plants.

386 VIBRATION FATIGUE TEST MACHINES

All American Tool & Mfg. Co.—13-page Catalog F26 describes models of vibration fatigue test machines. Models for handling parts or assemblies from 10 lb to 150 lb in weight. Both horizontal and vertical table motion types. Manual or automatic frequency cycling.

YOUR *New Catalogs* GUIDE

387 BRONZE, IRON BODY VALVES

Fairbanks Co.—Catalog No. 51 provides complete descriptions and specifications on bronze and iron body valves. Bronze valves of all types with pressure ratings from 125 thru 300 lb steam working pressure are covered, along with bronze solder end and "Fairco-Braze" threadless valves. Iron body valves of all types including clip-gates with pressure ratings from 125 thru 250 lb steam working pressure are listed.

388 WATER CONTROL EQUIPMENT

Rodney Hunt Machine Co.—A 250-page catalog covering sluice gates, timber gates, hoists, fabricated gates, racks and rakes, valves and engineering data on water control is offered to consulting engineers, contractors and others actively engaged in water control construction work. The section on sluice gates covers 2000 combinations of standard types and sizes.

389 ADJUSTABLE-SPEED DRIVES

Reliance Electric & Engrg. Co.—Bulletin D-2102 describes V-S Jr. drive. Completely packaged and all-electric, this adjustable-speed drive furnishes stepless adjustable speeds from a plant's a-c circuit. These packaged ¾ to 3 hp drives consist of an operator's control station, adjustable-speed drive motor, and control unit. Applications, functions, dimensions, characteristics, and auxiliary equipment are also presented.

390 TURBINE LUBRICATION

Murray Iron Wks. Co.—Bulletin T-125 discusses lubrication requirements of all types of the company's turbines. A lubricating oil recommendation chart is also included. This bulletin also serves as a general catalog, illustrating single stage and multi-stage mechanical drive turbines, vertical turbines and turbo-generating units in sizes up to 3000 kw.

391 GAGES

U. S. Gauge Div., American Machine and Metals, Inc.—Catalog 1819 provides illustrated information describing a new line of gages with all adjustments from rear without removing dial and pointer.

392 ATOMIC MATERIALS

Norton Co.—A 16-page instructional booklet covers the use of boron carbide and elemental boron in the atomic energy program. Tables and curves of properties are included in this illustrated booklet.

393 WATER VAPOR PHYSICS

Pittsburgh Lectrodryer Corp.—Bulletin No. 218, "The Moisture in Our Atmosphere," a 12-page bulletin, discusses the fundamental physics of water vapor. The nature and behavior of water vapor are treated in a logical down-to-earth manner with psychrometric chart explanations. Solid adsorption equipment for dehumidification is also described.

394 STEEL WIRE

American Chain & Cable Co., Page Steel & Wire Div.—A 16-page, DH-1226, catalog on Page shaped wire includes specification tables, range of sizes, physical properties of steel wire, table of standard wire gages, hardness conversion tables, with illustrations showing how to calculate areas of typical common shapes of wires. Size range includes cross-sectional areas up to and including No. 3 BWG; flats and rectangles in widths up to ⅔ in., the ratio of width of thickness not exceeding 6 to 1.

395 PROPORTIONAL BURNERS

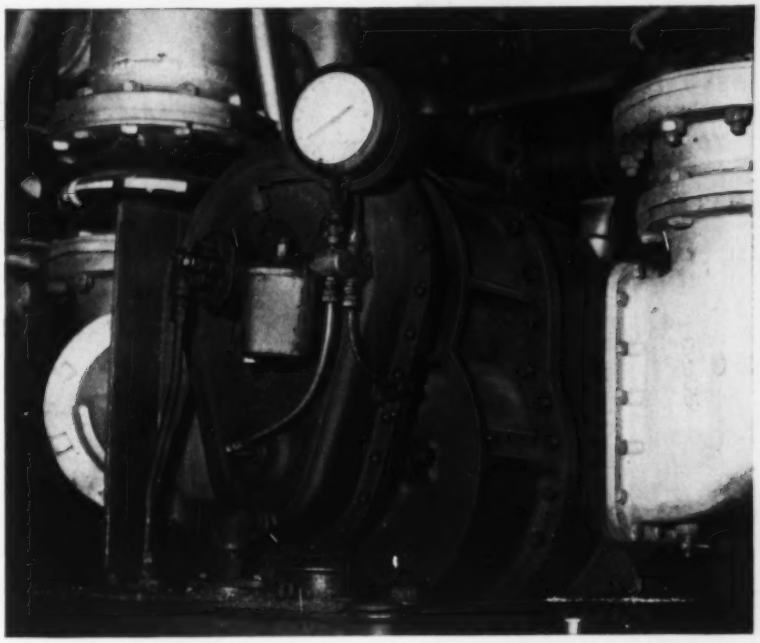
Anthony Co.—Data sheets cover proportional, air atomizing, steam atomizing types of burners with application drawings, capacities, dimensions, cross-sections and full details.

396 CLEANABLE FILTERS

Cuno Engineering Corp.—Literature covers Auto-Klean edge-type cleanable filters, and filters for built-in installations.

397 ADJUSTABLE PIPE HANGERS

Blaw-Knox Co., Power Piping and Sprinkler Div.—New 100-page Catalog 54 features the Blaw-Knox functional spring hangers, vibration



Operates 15 months at 165% overload—
not a sign of wear

A large eastern chemical company, requiring a continuous high volume of air, installed the 980 pound Standardaire Blower shown above to replace a 4800 pound blower of competitive manufacture.

This Standardaire model, a low pressure unit rated to operate at 1750 rpm and 4.5 psi, was forced to operate at 2200 rpm and 12 psi day and night, out of doors . . . for 15 months. During that time, it moved approximately 1⅓ billion cubic feet of air.

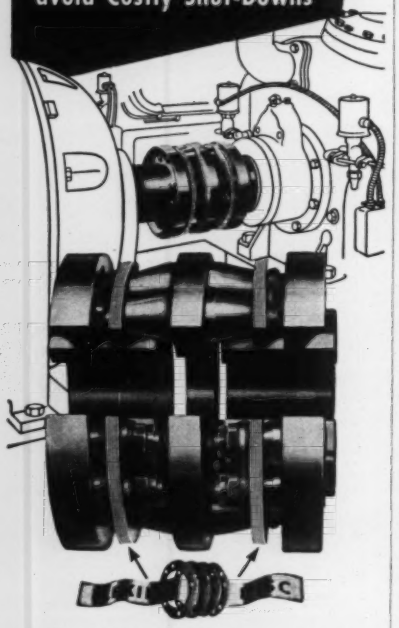
Disassembled to determine the effects of this gruelling run, engineers detected no discernible sign of wear. The main and gate rotors were like new. The interior was completely dry and free of oil. Axial clearance of the main rotor shaft thrust-radial bearing had increased less than 0.0005 in. Other bearings were in perfect order.

Reports such as this are not unusual. Standardaire Blowers installed throughout this country and others are performing under exceptional overload conditions for extended periods without maintenance other than lubrication. These units provide greater capacity per pound of blower with less power consumption than any other make. Write for complete information.

READ STANDARD
CORPORATION

BLOWER-STOKER DIVISION
370 LEXINGTON AVENUE, NEW YORK 17, NEW YORK

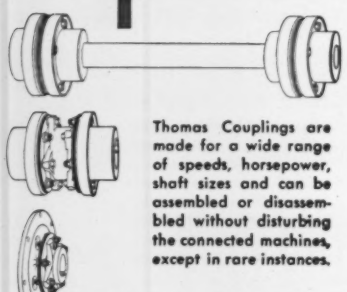
Specify THOMAS ALL METAL
FLEXIBLE COUPLINGS
for Power Transmission to avoid Costly Shut-Downs



Patented Flexible Disc Rings of special steel transmit the power and provide for parallel and angular misalignment as well as free end float.

DISTINCTIVE ADVANTAGES

FACTS	EXPLANATION
NO MAINTENANCE	Requires No Attention. Visual Inspection While Operating.
NO LUBRICATION	No Wearing Parts. Freedom from Shut-downs.
NO BACKLASH	No Loose Parts. All Parts Solidly Bolted.
CAN NOT "CREATE" THRUST	Free End Float under Load and Misalignment. No Rubbing Action to cause Axial Movement.
PERMANENT TORSIONAL CHARACTERISTICS	Drives Like a Solid Coupling. Elastic Constant Does Not Change. Original Balance is Maintained.



Thomas Couplings are made for a wide range of speeds, horsepower, shaft sizes and can be assembled or disassembled without disturbing the connected machines, except in rare instances.

Write for new Engineering Catalog No. 51A

THOMAS FLEXIBLE COUPLING CO.
WARREN, PENNSYLVANIA, U.S.A.

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eliminators, and overhead roller assemblies. The improving and simplifying of complicated piping systems is explained by charts and drawings. A Technical Section enables a piping engineer to solve most hanger load problems and thus determine the hanger requirements for the particular piping under consideration.

398 AIR-COOLED ENGINES

Wisconsin Motor Corp.—Bulletin S-188 includes condensed specifications covering the company's heavy-duty air-cooled engines and shows power and torque curve diagrams, dimension diagrams, construction specifications and illustrations of the engines' features.

399 MATERIALS HANDLING

Gifford-Wood Co.—Bulletin No. 400 shows special applications of equipment for mechanical handling of materials in every branch of industry. The information is presented to consulting engineers, plant owners and plant engineers for selecting equipment to handle raw materials in bulk and packaged goods in various forms and units.

400 IN-LINE DESURGER

Westinghouse Air Brake Co.—A 4-page bulletin illustrates and describes a dual-acting, in-line desurger for eliminating damaging surge, pump pulsation, water hammer shock.

401 BIN LEVEL CONTROLS

Bin-Dicator Co.—Catalog describes and illustrates bin level indicators including new Roto-Bin-Dicator and Bin-Flo aerator units. Dimensional drawings, mounting details, typical applications, wiring diagrams, and list of present users.

402 CONVEYOR SCALES

Merrick Scale Mfg. Co.—Bulletin 851 describes control of remote equipment by means of an automatic conveyor scale. Bulletin covers electrical, mechanical and pneumatic regulation of remote tie-in equipment as well as liquid-solid proportioning.

403 BRONZE VALVES

Ohio Brass Co.—An 88-page bound catalog, No. 57, illustrates, describes and gives specifications on globe and angle valves, gate valves, check valves, radiator valves, balancing valves and special valves made of bronze for industrial and residential use.

404 SPREADER STOKER

Detroit Stoker Co.—A 16-page catalog describes the company's type C-C continuous ash discharge spreader stoker designed for firing all types and makes of modern boilers from approximately 5000 to 75,000 lb per hr steam capacity. Photographs and diagrams of typical installations are included.

405 GLOBE, ANGLE VALVES

Kennedy Valve Mfg. Co.—Bulletin No. 110, describes new 500 Brinell line of bronze globe and angle valves. Features include seats and disks of cutlery grade, true 500 Brinell stainless steel, precision machined on specially designed equipment. Both seats and disks are polished to a 10μ in., smoothness for perfect leak-proof seal.

406 COLD ROLL-FORMING

Yoder Co.—An 88-page booklet tells the story of the equipment for and process of cold roll-forming, and uses of its products, their advantages and commercial possibilities. Also listed are auxiliary equipment for curving, coiling, ring-forming, notching, perforating, welding, embossing, automatic cut-off.

407 TANKS

W. E. Caldwell Co.—Storage and processing tanks Catalog No. 61 covering steel and wood tanks for every type of service—including capacities, illustrations, price data and technical information on elevated tanks for industrial use, fire protection and water systems—other standard and special designs for the various industrial uses.

408 DIGITAL CONVERTER

Fischer & Porter Co.—Catalog 58-10 illustrates and describes the firm's line of digital converters, electro-mechanical shaft position types and voltage types. Operation, characteristics, accuracy and specifications are described and illustrated with photos, drawings and installation diagrams.

409 CIRCULATION HEATERS

Edwin L. Wiegand Co.—Bulletin 701 describes and illustrates the advantages and typical applications of a line of automatic electric circulation heaters. These units are available for controlled heating of water, oils, heat-transfer media, steam and air and other gases.

410 AUTOMATIC CONTROLS

Mercoid Corp.—Catalog Number 856, a 52-page reference book for engineers, contains information on automatic controls for pressure, temperature, liquid level, and mechanical movement. Transformer-relays and mercury switches are also listed.

411 FLEXIBLE SHAFTING

Elliott Mfg. Co.—Circular 247 shows applications of flexible shafting in conveyor systems, printing machines, outboard motors, gas engines, mixers, grinders, farm and automotive equipment. A selection chart is also included.

412 LIQUID METERS

Buffalo Meter Co.—Catalog of Niagara Industrial Meters, Bulletin No. 36, describes the company's line of volumetric meters for industrial liquids including chemicals, oils, solvents, hot water, cold water, syrups, acids, and alkalies. Automatic batch-measuring equipment is described.

413 STAMPED GEARS

Winzeler Mfg. & Tool Co.—A 4-page illustrated bulletin describes stamped gears: spur, crown, pinion, spur and pinion clusters, laminated and special types. Gear data and tables are included. Also available is a 4-page stock gear die list including 8-96 diametral pitch spurs, 14½ and 20 deg pressure angle; crown gears, 24-64 diametral pitch.

414 COMBUSTION EQUIPMENT

Hauck Mfg. Co.—The Catalog 52 gives a condensed and pictorial review of oil and gas combustion equipment for production, construction, and maintenance applications in industry. The catalog has 12 pages and 80 illustrations.

415 MARKING MACHINES

Jas. H. Matthews & Co.—A four-page folder illustrates and describes bench-mounted, hand-operated, pneumatic, and hydro-pneumatic marking machines for metal products. Specifications are given, and accessories are listed.

416 REDUCTION EQUIPMENT

American Pulverizer Co.—Literature describes reduction problems of various processing industries. Construction and operating features, specifications are fully discussed and illustrated. Bulletins are available on coal crushers, stone crushers, metal turnings crushers, plastics granulators, wood hogs.

417 DRAWING MATERIALS

Eberhard Faber Pencil Co.—A new catalog in full color, illustrates line of drawing materials for artists, engineers, designers, draftsmen and architects. It includes a wide variety of drawing and colored pencils, marking instruments, pastels and erasers.

418 COMPRESSION PIPE COUPLINGS

Morris Coupling and Clamp Co.—A series of bulletins illustrates and gives application data on compression pipe couplings and band type pipe repair clamps. Application photos, diagrams and specification tables are included.

419 ELECTRONIC WEIGHING

Streeter-Amet Co.—An article reprint, "Determining Weight Electronically," outlines and illustrates basic scale systems, limitations, power

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supplies, circuit shielding and instrumentation in the use of electronics for determining weight in such applications as cranes, railroads, and hoppers.

420 STEAM GENERATORS

Ames Iron Works, Inc.—Bulletin AXY-1 describes basic pressure vessel construction, boiler trim, auxiliary equipment and controls furnished on models A, X or Y steam generators.

421 TITANIUM ALLOY

Kennametal Inc.—Folder describes Kentanium, a new heat-resistant titanium alloy that resists thermal shock, withstands oxidation, and retains great strength at high temperatures (1800 F and above).

422 CLUTCHES, BRAKES

Warner Electric Brake & Clutch Co.—Bulletin No. 6170 describes a complete line of electric clutches and brakes from 8 in. lb to 700 ft lb of torque. Also illustrated is a new line of stationary field clutches and replaceable face brakes utilizing the company's new induced magnetic circuit design.

423 MECHANICAL ENGINEERING BOOKS

John Wiley & Sons—A bulletin describes the spring list of books in all phases of mechanical engineering. Short descriptions, authorship, and prices are included on new titles. Also included is a more extensive listing of standard mechanical engineering works covering all aspects of the field.

424 STEAM GENERATORS

Union Iron Works—Literature describes line of water tube steam generators from packaged type units for oil and gas fuels or shop assembled coal fired units to field erected water tube steam generators burning all commercial fuels, superheaters, economizers, air heaters, waste heat boilers and other auxiliaries; many illustrations included.

425 FURNACE CONSTRUCTION

M. H. Detrick Co.—A 50-page illustrated booklet, "Heat Enclosure Methods," outlines the development of furnaces and furnace construction. Suspended arch and wall constructions and their applications are shown for boilers, oil heaters, heating and melting furnaces, and other units. Engineering graphs and tables are presented.

426 DIE CASTING MACHINES

Lake Erie Engineering Corp.—Bulletin 255 illustrates and describes a new series of expandable die casting machines which feature a knuckled wedge cam toggle, improved manifold valving, flexible sequence corepull valving, and the firm's "Pressure-Pac" for providing added pressure needed to shrink or compress the porosity at the time of solidification of the metal.

427 HIGH PRESSURE BLOW-OFF VALVES

Yarnall-Waring Co.—A 24-page bulletin on boiler covers blow-off valves for pressures from 600 to 2500 psi. Described are seatless and hard-seat-type valves, and unit tandem type valves combining both blowing and sealing valves in a common forged-steel body.

428 MOLDED RUBBER GOODS

Hewitt-Robbins, Inc.—Bulletin H-20 illustrates and gives specifications on molded rubber goods and industrial sheet packing in both synthetic and natural rubber.

429 RUST PREVENTION

Rust-Oleum Corp.—A general catalog contains 102 color chips showing colors available in primers, short oil type coatings, oil field finishes, restful color group finishes, machinery and implement colors, long oil type coatings, Galvinoleum coatings, heat resistant coatings, chemical resistant coatings, floor and deck coatings.

430 SPECIAL GLASSES

Corning Glass Wks.—Properties of such selected commercial glasses as Pyrex, Corning and Vycor are described in bulletin B-83. Data and tables on mechanical properties, thermal stresses, heat transmission, electrical properties, corrosion resistance, and viscosity are included.

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Today, there are innumerable openings for engineers. But, if you are an ambitious, creative technical man, you want more than just a job. You want *opportunity* — an opportunity to build a real future.

At Pratt & Whitney Aircraft, we are doing work on an atomic engine for aircraft. The degree of progress is classified, however, you may be sure that there are still challenging problems where you can demonstrate your creative abilities.

Ours is a progressive organization — quick to recognize and reward professional achievement. Thus, if you can qualify, you will have a rare opportunity to build toward a fine future in this new engineering field.

If you are looking toward "tomorrow" — send your complete resume immediately to Mr. P. R. Smith, Office 14, Employment Department.

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• New, Higher Salary Levels • New, Advanced Educational Program: A nearby graduate center, established in conjunction with Rensselaer Polytechnic Institute, offers training toward advanced technical degrees. All employees accepted for courses are eligible for tuition assistance.

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431 POLYVINYL PIPE

National Tube Div., U.S. Steel Corp.—Bulletin 24 gives properties and specifications of both high-impact and normal impact polyvinyl chloride pipe. A section covers installation procedures. The chemical resistance of the plastic pipe is compared with pipe of other materials.

432 VIBRATION MEASUREMENT

General Radio Co.—A 64-page booklet, "Measurement of Vibration," covers vibration terms and typical examples and applications. Vibration-measuring instruments are described and illustrated.

433 MAGNESIA INSULATION

Aero Research Instrument Co.—A bulletin on swaged magnesia insulation is illustrated with the various designs of their construction and uses. Instructions on attaching the connectors and making thermocouple junctions are included.

434 TIME-FILL DIAGRAMS

Hays Mfg. Co.—A series of specific time-fill diagrams are available to assist engineers in calculations of time-fill requirements. The diagrams pertain to the firm's valves.

435 PRESSURE VESSELS

L. O. Koven & Bro., Inc.—Bulletin No. 550 illustrates and describes mixers, kettles, vacuum and pressure vessels, autoclaves, evaporators, impregnators, condensers, stills, extractors, tanks, standpipes, piping, stacks.

436 FLOW REGULATOR

Waterman Engineering Co.—An illustrated bulletin covers an adjustable flow regulator that is adapted for panel mounting on systems requiring a variable adjustment of the flow rate over a wide operating range.

437 STEREOMICROSCOPES

Bausch & Lomb—A catalog discusses principles and equipment used in connection with stereomicroscopy. A guide to the selection of stereomicroscopes and accessories is included, along with reproductions of specimens seen through this medium.

438 INSULATION, REFRACTORIES

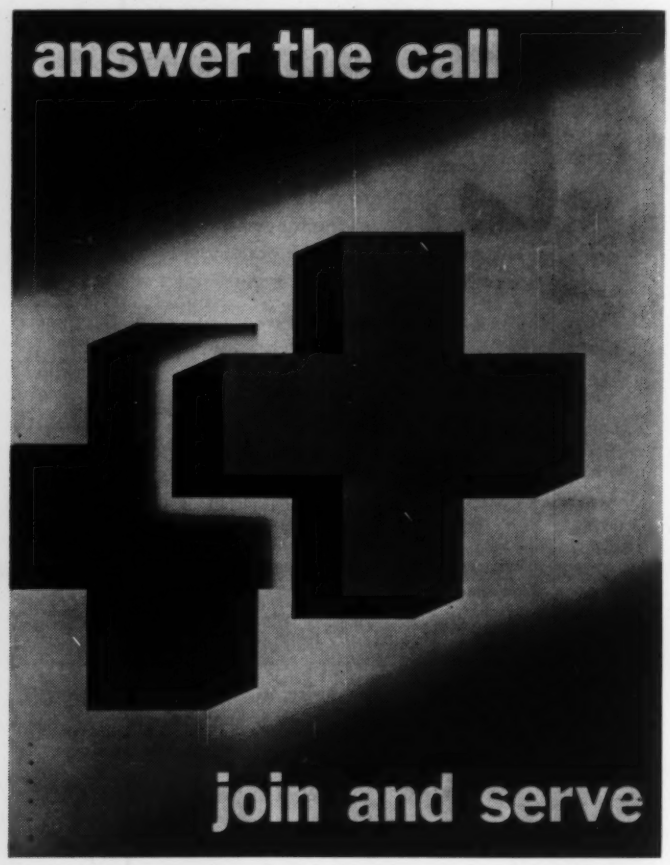
Johns-Manville—A 52-page bulletin illustrates and describes eleven lines of products: insulations and refractory products; transite asbestos-cement pipe; packings and gaskets; electrical products; Celite diatomite filter acids and mineral fillers; Celite diatomite catalyst carriers and metal Raschig rings; synthetic silicates; friction materials; pipe protection materials; floorings.

439 DUAL DRIVE ADAPTER

F. W. Stewart Corp.—A bulletin covers a dual adapter for use in conjunction with flexible shaft drives where more than one unit is to be driven from the same power source.

440 CODE PRINTERS

Pannier Corp.—A bulletin illustrates and describes special code printers use for marking sheet products. Included is a sheet surface printer, drum type printing roll, handle-feed single wheel printer, adjustable multi-wheel printer, and shaft feed drum type printing unit.



441 PNEUMATIC CONVEYORS

National Conveyors Co., Inc.—Catalog P-56 shows uses of pneumatic conveyors for ash removal in steam plants; collection, processing and reclamation of cutting oils, chips and borings in the metal working industry; and the handling of dry, pulverized or granular materials in other industry.

442 COMPRESSED AIR

Hankison Corp.—An article reprint discusses the removal of contaminants from compressed air.

443 STAINLESS STEEL PIPE

Pypon Co.—Catalog 53 illustrates and describes stainless steel welding fittings and welded pipe. Elbows, returns, stub ends, caps, concentric and eccentric fittings are shown. Specifications and dimensions are tabled.

444 BOILER SERVICE VALVES

Everlasting Valve Co.—Bulletin describes the Everlasting Quick-Opening and Slow-Opening Straightway Valves, Angle Valves, Y Valves, and Duplex Blow-Off Units, with specifications, materials of construction, and dimensions of each type. Illustrations include details of design, sectional and exploded views, and explanations of operation of the valves. A section of the bulletin also describes Everlasting Valves for fire protection.

445 V-BELT DRIVES

Allis-Chalmers Mfg. Co.—Bulletin 20B6051 carries the procedure for figuring "Texrope" V-belt drives by means of tables, together with examples of how to use the engineering information given. The bulletin also describes "Texrope" belts, sheaves, and speed changers.

446 DIE CASTING

Parker White Metal Co.—A booklet contains American Die Casting Institute standard specifications, tolerance tables and physical properties of die casting alloys. The material has been compiled to help engineers and buyers make more effective use of the design, material and cost saving advantages of die cast component parts.

447 TECHNICAL BOOKS

Lefax Publishers—Over 2000 listings of Lefax pocket-size technical books are contained in the newly revised 1956 Lefax list of technical data sheets. Condensed, mathematically accurate source materials for engineers, construction men, technical workers, and technical students. Each book consists of approximately 140 pages of easily read tables and data in pocket-size, loose-leaf form for handy reference right on the job.

448 CENTRIFUGAL PUMPS

American-Marsh Pumps, Inc.—6-page Bulletin 350 describes horizontal split case, single stage, double suction centrifugal pumps. Types HLM and HIM for wide range of capacity and head conditions. Large sectional view explains 18 important features. Specifications, performance data and dimension tables are included.

449 GAS UNIT HEATING

Reznor—Technical and application data on the use of gas unit heating is illustrated and described in a 20-page bulletin, SA-541. Diagrams and tables outline specifications, gas line requirements, and heat loss estimating factors.

450 GROOVING TOOL

Waldes Kohinoor, Inc.—Catalog No. GT2-53 presents general information, engineering specifications, and manufacturing technical data for the Waldes Truarc grooving tool. The manual is illustrated with a number of tool setups and explains the functioning of the tool, particularly its economic performance on recessing operations. It also includes typical applications, dimensions and conversion tables, and ordering specifications.

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451 FLUID COUPLINGS

Twin Disc Clutch Co.—Bulletin No. 144-D gives installation and performance data on fluid couplings. Complete with diagrams and drawings, the bulletin shows the use of the firm's couplings on any type of industrial equipment powered by electric motors or internal combustion engines from 3/4 to 850 hp.

452 HEATERS

Dravo Corp.—Bulletins 523-B and 552 cover the firm's forced air space heaters for comfort heating, year-round ventilating, tempering make-up air, process drying, heat curing. The units are direct fired by oil, gas or combination fuels.

453 HYDRAULIC PUMPS

American Engineering Co.—Two bulletins cover high and low pressure hydraulic components. One describes variable discharge pumps with capacities from 1 to 66 gpm with pressures to 3000 psi; another, constant discharge pumps of 3 to 100 gpm, 5000 psi.

454 O-RINGS

Goshen Rubber Co., Inc.—A 12-page brochure gives detailed information on compounds, groove dimensions and sizes of O-rings. Diagrams of typical applications are included.

455 HYDRAULIC PRESS

Denison Engineering Co.—Bulletin 120C has 24 pages of facts and figures about Denison hydraulic Multipress designed to perform hundreds of jobs requiring 1 to 75 ton pressures. It is available in 10 frame sizes, bench and floor models. Standard accessories include servo-control, index table, dial feed, stock feed, foil marking accessory.

456 PACKAGED BOILER UNIT

Fitzgibbons Boiler Co.—Catalog FPB-10 describes a new packaged boiler unit as a completely coordinated low-pressure heating package, fire-tested at the plant and shipped ready to operate with oil, gas or combination. An exclusive feature is the water-jacketed rear furnace wall that eliminates the need for rear refractory. Thirteen sizes range from 39 to 464 hp.

457 PARALLEL SHAFT GEAR DRIVES

Link-Belt Co.—The firm's line of parallel shaft gear drives is described in a new 32-page book no. 2619. Listed are 39 standard size single, double and triple reduction drives, permitting a standard ratio selection from as small as 1.2:1 to as large as 323:1, with capacities of more than 2000 hp. Book also contains engineering data, including simplified horsepower tables, dimensions, and overhung load capacities for selection from the standard line. Base-plates and built-in backstops are also covered.

458 DIRECT FIRED HEATERS

Arthur A. Olson & Co.—Bulletin A1A No-30-B-1 illustrates and describes stainless steel direct fired heaters with capacities of 300,000 to 2,000,000 Btu output. A cutaway photo and a table of general dimensions are included.

459 STOKER PIERS AND SILLS

Bernitz Furnace Appliance Co.—Brochure describes advantages of air-cooled "Carbofrax" piers and sills in new construction as well as replacement. Pictorially depicts typical installations. Points up savings in maintenance and boiler outage or downtime, improved combustion and elimination of spalling, fly ash and clinker adhesion.

460 TURBINE PUMPS

Roy E. Roth Co.—Bulletin No. 107 describes and illustrates the firm's new line of regenerative turbine pumps designed for boiler feed service with boilers up to 1000 hp and operating at pressures up to 300 psi. These pumps are two stage. Ten models in the 2000 series and nine models in the 3000 series are available in standard fitted, bronze fitted, all iron and all bronze construction.

461 ALUMINUM CASTINGS

Thompson Products, Inc.—An 8-page booklet illustrates and describes the company's facilities for making aluminum and magnesium castings for electrical, commercial, automotive and aircraft use. A section of the booklet covers various castings made for each of these industry groups, and another section discusses the firm's engineering, production, machining and quality control.

462 DUST COLLECTOR

Ducon Co.—Technical literature gives data on the firm's series of UW-3 centrifugal wash collectors. The collectors, described as package units, combining exhauster and precipitator components, have been extensively used to control dust and fumes and to reclaim materials. They have handled carbon black, limestone, pigments and glazing particles with efficiencies of more than 99 per cent by weight.

463 FLEXIBLE METAL HOSE

Flexonics Corp.—A 12-page catalog covers line of Flexon flexible metal hose. The three main types of flexible metal hose and their specifications are given, typical applications are told, couplings available described, and a chart on how to select metal hose is included.

464 CHROMIUM PRODUCTS

Van der Horst Corp.—A bulletin covers, in question and answer style, the properties and application of the firm's Porus-Krome, a pure hard chromium applied to cylinder bores and other bearing surfaces by a process which produces pores to hold lubricating oil.

465 INTERFEROMETER

Link Aviation, Inc.—A leaflet is available describing the Link Fringecount micrometer which is a measuring device using the light interference principle. Measurements up to two inches are possible, with accuracy claimed of one millionth of an inch. Gage blocks, plug gages, and ball and roller bearings measured, and flatness checked.

466 CONVEYOR APPLICATION

Falk Corp.—Report 550902 illustrates the application of speed reducers and flexible shaft couplings on conveyor drives in a large, modern limestone quarry.

467 AFTERCOOLERS, SEPARATORS

R. P. Adams Co.—Bulletin 711 indicates ways in which aftercoolers and separators can save money for firms using compressed air. Included is a step-by-step checklist that shows how much moisture is being carried through a system. Cutaway illustrations and size charts of the equipment are included.

468 DRAFT INDUCERS

L. J. Wing Mfg. Co.—A 16-page booklet covers draft inducers for heating boilers and for power plants. The units are of packaged design, factory assembled, horizontal or vertical discharge with gas inlets on either side or top or bottom. Fan bearings are air cooled and pre-lubricated. Also included are illustrations of applications of the company's units and a discussion of the advantages of correct draft in industry.

469 MICROHONING

Micromatic Hone Corp.—A 32-page, two-color illustrated catalog contains description of the cylindrical and flat microhoning process and equipment, specifications and work capacities of horizontal, vertical and microflat machines; automated microhoning; representative range of tools, fixtures and abrasives; short explanation of automatic size control; availability of job service, film and literature aids.

"Long after price is forgotten Quality is still remembered"

Golden-Anderson has never sacrificed quality just to "close the order." For over 50 years we have been designing and manufacturing valves that give dependable operation . . . that need little maintenance . . . that last a lifetime.

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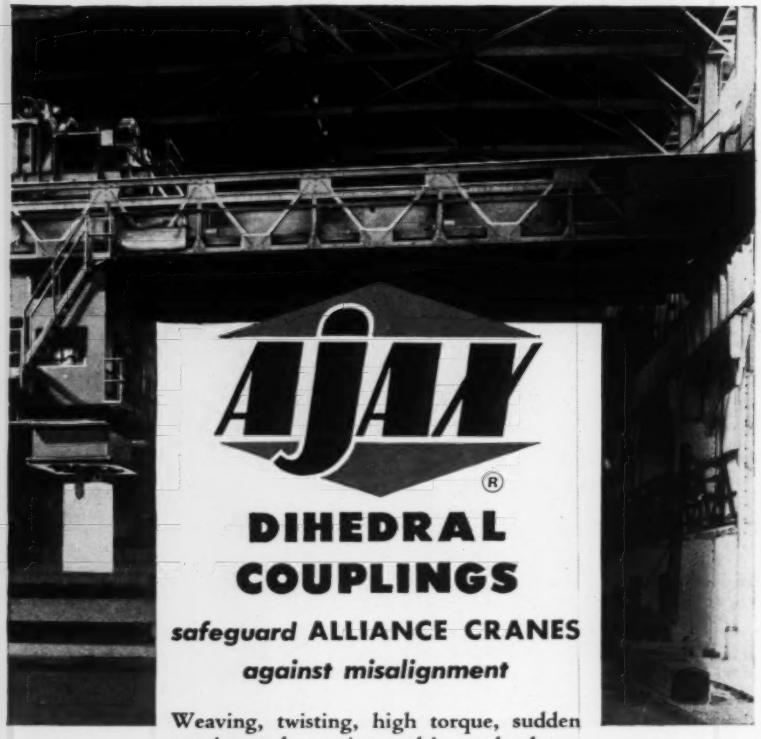

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DIHEDRAL COUPLINGS

***safeguard* ALLIANCE CRANES**

against misalignment

Weaving, twisting, high torque, sudden starting and stopping and heavy loads are being handled on many Alliance Cranes by Ajax Dihedral Couplings. Ajax Dihedral Couplings protect motor housings and bearings, winches, and running gear.

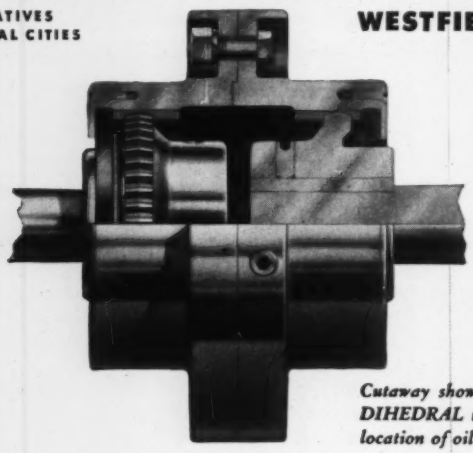
Ajax patented dihedral tooth design has less clearance than conventional gear type couplings. More tooth strength is provided under misalignment than is possible with any other tooth shape. Load is distributed at center of teeth at the point of greatest strength. Johns-Manville "Clipper" Seals keep lubricant in and foreign matter out.

Design engineers are invited to get the facts on Ajax Dihedral Couplings on this basis,— if you have alignment or misalignment troubles you can't afford to be without Ajax Dihedral Couplings! Tell us your troubles.

AJAX FLEXIBLE COUPLING CO. INC.

REPRESENTATIVES IN PRINCIPAL CITIES

WESTFIELD, N. Y.



Cutaway shows Ajax patented DIHEDRAL tooth design and location of oil seals.

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470 PLUG VALVES

Homestead Valve Mfg. Co.—A 28-page reference book, No. 39-5 shows lubricated plug valves in full-port and venturi types, sizes up to 20 in., with a choice of standard, round port or diamond port plugs. Engineering information includes principal dimensions, types of control, metals.

471 HIGH-SPEED QUENCHING OIL

Shell Oil Co.—An 8-page folder describes Voluta oil 23, a premium quenching oil designed for maximum speed with minimum distortion. The booklet explains the mechanics of hardening, and includes center cooling curves for several test oils, hardness curves for standard quench cones, and photos of the test cones sectioned after hardening.

472 FORGINGS

Drop Forging Assn.—A six-page booklet, entitled "Management Guide to the Use of Forgings," states the advantages forgings offer to the designer, metallurgist, purchasing agent and executives.

473 PIPE INSULATION

Philip Carey Mfg. Co.—Literature describes a new universal pipe and block insulation from all temperatures from 100 to 1600 F, for oil stills, ovens, boiler walls, breechings, furnaces.

474 GAGES AND INDICATORS

Ernst Water Column & Gage Co.—Bulletin 3-14-55 has been released, covering some of Ernst specialties, such as bronze, iron, and stainless steel liquid-level gages; also trycocks, illuminators, and flow indicators.

475 AUTOMATIC SCALE

Exact Weight Scale Co.—A four-page bulletin illustrates and describes automatic scales and auxiliary equipment for weighing, classifying and sorting products in precise over, under and correct weight groups.

476 BALL BEARINGS

Federal Ball Bearings Co.—Catalog D-1 contains 24 pages of dimensional tables for selection of ball bearings according to size, and assists in the identification of ball bearings for which a replacement is required. Both metric and inch measurements are shown. Catalog also includes interchange and conversion tables.

477 AUTOMATIC VALVES

Rivett Lathe & Grinder, Inc.—Hydraulic valves, solenoid controlled and panel mounted, are illustrated and described in eight-page Catalog No. 261. This catalog describes Rivett Solenoid 4-way Subplate Mounted.

478 CORROSION-RESISTANT CASTINGS

Shenango-Penn Mold Co.—Bulletin 151, 6 pages shows photographs of typical centrifugal castings produced by the company in Meehanite and Ni-Resist metals and other special iron alloys.

479 FORGED STEEL FITTINGS

W-S Fittings Div., H. K. Porter Co.—New 24-page catalog, A-3-56, describes line of W-S forged carbon steel pipe fittings in screw-end and socket-welding types for high pressure service. Included are engineering specifications, dimensional data and other technical information. Applications are also described and illustrated.

480 MINIATURE BALL BEARINGS

Landis & Gyr, Inc.—Twelve-page catalog covers RMB miniature ball bearings in five types, in addition to special series and miniature roller bearings. Engineering and design data are appended. Illustrations of typical applications are given for each type.

481 SMOKE DENSITY ESTIMATOR

Mine Safety Appliance Co.—Leaflet and technical article reprint describe the operation of the MSA Smokescope, an optical instrument for making estimations of the density of smoke in stack effluent. The instrument uses comparison with a reference disk.

482 PUSH-PULL CONTROL

Controlex Corp. of America—Four-page bulletin describes precision built push-pull control consisting of a solid, flexible stainless steel blade moving between rows of stainless steel balls and housed in a flexible tubing.

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CASE HISTORY of an ENGINEER'S PROGRESS from the personnel files of HAMILTON STANDARD

Edward Wallace*

Graduate of Penn State, B.S. Aeronautical Engineering

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2/16/50	Engineering Training — Post Graduate
7/16/50	study at Rensselaer Polytechnic Inst.
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10/16/51	Installation Engineer A
7/1/52	Senior Installation Engineer
7/1/55	Assistant Project Engineer

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YOUR *New Catalogs* GUIDE

483 AUTOMATION MACHINERY

Barth Corp.—New 44-page catalog shows special automation machinery, tools, dies, stampings, servo mechanisms, electric control panels, etc. produced for the automotive, aircraft and appliance industries.

484 BOILERS AND STOKERS

James Leffel & Co.—Bulletin 236 gives descriptive and specification information and performance data on the firm's gas-, oil-, and coal-fired Scotch boilers and on underfeed stokers for use with Scotch boilers.

485 RETAINING RINGS

Eaton Mfg. Co., Reliance Div.—A catalog describes the design and application of the firm's line of snap bearing lock and retaining rings, spring lock washers, spring washers—preassembled on bolt or screw—self-tapping screws, one-piece hose clamp.

486 PRECISION INSTRUMENTS

Bendix Aviation Corp., Friez Instrument Div.—Catalog No. 11 covers precision instruments for meteorological and industrial applications as well as numerous related devices for home and factory.

487 BEARINGS, BUSHINGS

Cleveland Graphite Bronze Co., Div. Clevite Corp.—A 16-page Catalog gives data on engineering, material analyses and applications of bearings, bushings, wear plates, thrust bearings and related products.

488 CONDENSER, HEAT EXCHANGER

Bridgeport Brass Co.—A 162-page illustrated handbook covers copper alloy tubes for condensers, heat exchangers, evaporators and general piping used in power plants, ships, oil refineries, chemical and petrochemical plants and process industries.

489 SMOKE ALARM

Heat-Timer Corp., Standard Instrument Corp. Div.—Literature covers a smoke density indicator-alarm, an indicating smoke alarm, smoke alarm units, and a combustion control for rotary cup oil burners.

490 PROCESS HEATING EQUIPMENT

Union Iron Wks.—A four-page folder illustrates and describes vaporizers and forced circulation liquid heating and cooling units for use in the process industries. Diagrams and dimension tables of the units are included.

491 ANALOG COMPUTING COMPONENTS

George A. Philbrick Researches, Inc.—A 16-page Catalog covers line of electronic analog computing components. It graphically demonstrates the use of the modular concept in building a computor installation.

492 TRACING PAPERS

Latmer Sales Co.—A folder contains samples of tracing papers with 4 × 4 non-reproducing cross sections. A price list is included.

493 SPECIAL ALLOY STEEL

Jones & Laughlin Steel Corp.—A 40-page Booklet contains case histories of Jalloy heat treated special alloy steel plate in such uses as trailer bodies, ore chutes, shovels and dipper sticks, picking tables, structural members, hammers, grader blades, dump truck, bottom line plates.

494 OPTICAL COMPARATORS

Jones & Lamson Machine Co.—Catalog No. 402-C illustrates and describes optical comparators. Typical applications are covered, and diagrams show the principles of construction and operation of the various units.

495 AUTOMATIC BAR MACHINE

National Acme Co.—A 10-page Catalog illustrates and describes the new Model M single spindle automatic bar machine, a universal, fully automatic metalturning lathe which can sustain fine tolerances at the fastest speed that tungsten carbide and high speed tools can be safely operated.

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YOUR

New Catalogs GUIDE

496 SPIRAL-WOUND GASKETS

Flexitallic Gasket Co.—A 28-page general Catalog illustrates and describes standard and non-standard flange gaskets and boiler gaskets. Construction features, gasket design and materials, specifications and characteristics, bolting data, facing dimensions and wall thicknesses of welded and seamless steel pipe are included.

497 HUMIDITY CONDITIONING

Kathabar Div., Surface Combustion Corp.—An 18-page Booklet shows applications of humidity control equipment in various industries. Problems, solutions and results of 12 case histories are included, along with data on how the system works.

498 LIFT TRUCKS

Hyster Co.—A Catalog describes new UC-30 and YC-40 Monomast lift truck models. These units feature a single upright or mast, and may be equipped with the extensive line of Hyster job attachments.

499 PIPE FITTINGS, FLANGES

Tube Turns Plastics, Inc.—Unplasticized polyvinyl chloride pipe fittings and flanges are the subject of a new booklet. It discusses industrial applications of PVC piping and gives complete specifications for threaded and socket types of fittings and flanges, in both normal and high impact grades.

500 ELEVATOR CHAINS

Beaumont Birch Co.—How service life of elevator chains can be increased from 300 to 400 percent over conventional chains is stated in Catalog DC-855. Dimensional drawings, tables of physical properties and relative corrosion resistance for various types of chain metals are included. Details on wheel pitch diameter, bore and weight are given.

501 TANK, VESSELS

Nooter Corp.—A 48-page Catalog describes facilities, workscope, techniques in custom fabrication of steel and alloy plate for processing industries. Corrosion data tables for various metals are included.

502 ATOMIZING DEAERATOR

Cochrane Corp.—Bulletin No. 4635 describes requirements and principles of deaerating by atomization, and the variety of combinations in heaters and storage tanks available from the company. The atomizing deaerator is also adaptable to marine applications.

503 STEAM PLANT EQUIPMENT

Yarnall-Waring Co.—A 12-page bulletin describes the full line of "Yarway" steam plant equipment: high, medium, and low pressure blow-off valves, water columns and gages, remote liquid level indicators, expansion joints, steam traps and strainers, spray nozzles.

504 PIPING INSULATION MANUAL

American Gilsonite Co.—A 20-page Booklet covers the methods of application of Gilsulate, a new insulation for hot underground pipes. It describes the three grades, how to determine ditch size for various pipes and types of soil, and gives sample problems.

505 STEEL GRATING

Blaw-Knox Co.—A 16-page bulletin illustrates and describes electroforged steel grating and treads for plants, sidewalks, stairs. A table of safe loads is included.

506 SOLENOID PILOTS

Spence Engineering Co.—A four-page bulletin describes several types of solenoid pilot for use with regulating valves in steam, air, gas and liquid service. Schematic diagrams of typical applications are included.

507 PLOTTER, RECORDER

Librascope, Inc.—An eight-page bulletin illustrates and describes XY plotters and recorders for application in research facilities, computer systems, controls and data handling systems.

508 BULK MATERIALS HANDLING

Hewitt-Robbins, Inc.—Bulletin 1029 covers bulk materials handling systems and equipment for solid and liquid materials handling, dry clas-

FLEXON® METAL HOSE *Operating Briefs*

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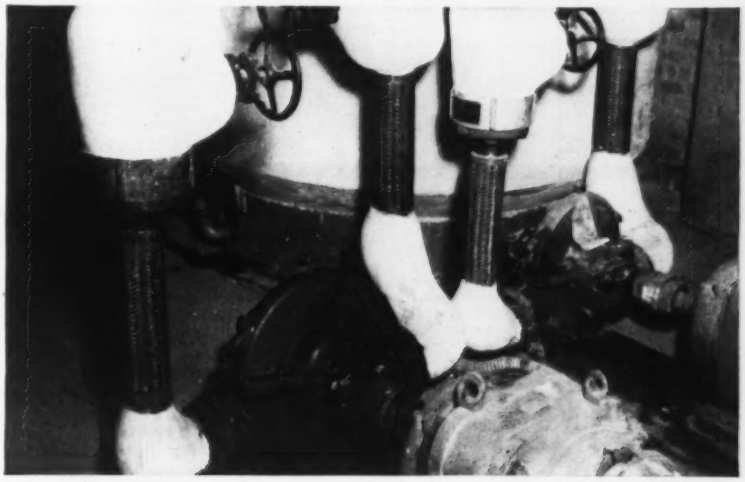

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CATALOG No. 152
gives basic specifications and application data for Flexon Metal Hose. Write for your copy, today.

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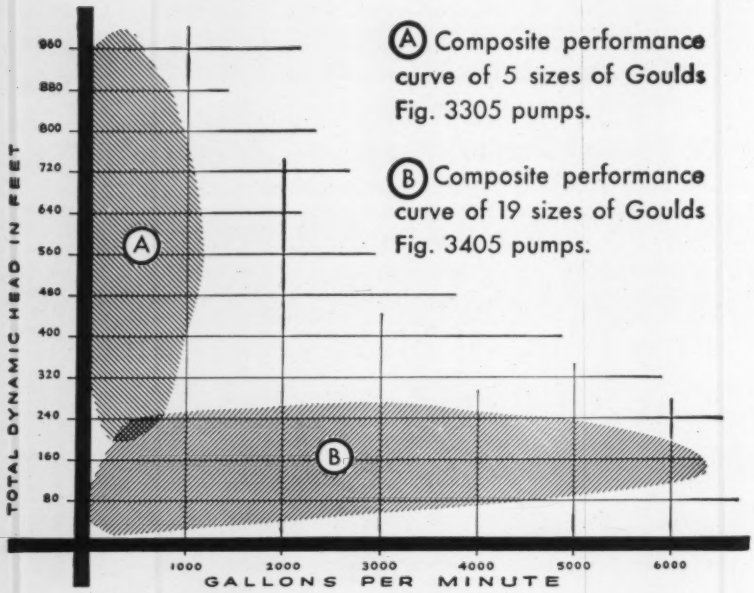

Ⓐ Composite performance curve of 5 sizes of Goulds Fig. 3305 pumps.

Ⓑ Composite performance curve of 19 sizes of Goulds Fig. 3405 pumps.

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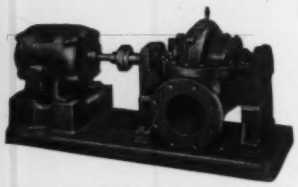
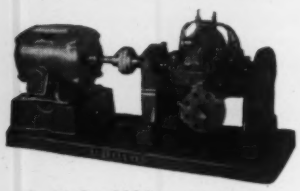
. . . or head? . . . or both?



Goulds Fig. 3405 single stage pump.



Goulds Fig. 3305 two-stage pump.

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For volume pumping, 19 sizes of the Fig. 3405 single-stage, double-suction pump provide capacities up to 6,400 GPM, and heads to 280 ft.

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YOUR *New Catalogs* GUIDE

sifications, feeding, blending. Typical installations are shown, along with photos of machinery and industrial rubber products manufactured by the firm.

509 MOTOR CONTROLS

Clark Controller Co.—An 84-page catalog covers manual and magnetic across-the-line starters, motor control centers, reduced voltage and synchronous motor starters, high voltage across-the-line starters, a-c and d-c contacters, a-c and d-c relays. Specifications and dimensions of all units are diagrammed and tabled.

510 OIL AND GAS FIRED BOILERS

S. T. Johnson Co., Mears, Kane, Ofeldt, Inc. Div.—Bulletins 2-K, 6-H, 7-D and 4-H cover line of gas, oil and combination oil and gas fired boilers from 1 to 30 hp, with the necessary automatic boiler feeds.

511 SELF-ALIGNING BEARINGS

Southwest Products Co.—Catalog No. 551 contains diagrams and specifications on Monoball self-aligning plain bearings and self-aligning rod end bearings.

512 ROTATING SERVOMECHANISMS

Norden-Ketay Corp., Precision Components Div.—Four-page bulletin No. 376 gives specifications and characteristics of a complete line of two phase servo motors, synchro receivers, synchro control transformers, synchro transmitters, induction motors, tachometer generators, pancake synchros, and resolvers.

513 CONTOUR MEASURING

Bausch & Lomb-A catalog illustrates and describes a contour measuring project for industrial measurement, comparison and inspection. Diagrams showing how the unit operates are included.

514 POLYETHYLENE

Koppers Co., Chemical Div.—Bulletin C-5-216 illustrates and describes the properties, processing and application of an improved polyethylene material. Sections cover heat resistance, rigidity, chemical resistance, low temperature toughness, tensile strength.

515 UNDERGROUND PIPE INSULATION

American Gilsonite Co.—A four-page Bulletin gives tips on the uses and installation of a new insulation for hot underground pipes. It explains how the material protects pipes against corrosion caused by acids and alkaline ground waters, and against bacterial action, roots and electrolysis.

516 RECORDING CHARTS

Technical Charts, Inc.—A new 12-page catalog outlines services in producing recording charts for standard and special instruments. It includes samples of both dial and roll type charts. The method of production of over 8000 different standard charts is outlined. Technical information is given on requirements for special charts.

517 FILTRATION EQUIPMENT

Croll-Reynolds Engineering Co., Inc.—Bulletin describes the company's method of filtration. Also included are specification data on sizes and capacities and a listing of the company's filtration facilities such as laboratory, pilot plant demonstrators and special engineering services.

518 OIL FIELD EQUIPMENT

Lufkin Foundry & Machine Co.—Catalog No. 56 lists specifications, descriptions and principal dimensions of conventional beam-type pumping units, air balanced pumping units, hydraulic long stroke units and gas engines for oil field applications.

519 PLUG-IN COMPUTING AMPLIFIERS

George A. Philbrick Researches, Inc.—A 32-page Booklet describes specific uses of plug-in amplifiers for analog computing. Summing, scaling, integration and differentiation plus combinations of these and other linear and non-linear transformations are shown with definite circuits.

520 ELECTRIC WELDED TUBING

Jones & Laughlin Steel Corp.—Literature gives specifications and characteristics of Electricweld tubing and its application on automobiles and in bicycle and furniture frames.

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LATEST INDUSTRIAL LITERATURE

GUIDE

521 REDUCING FLOW CAMERA

Peerless Photo Products, Inc.—Eight-page bulletin illustrates and describes improved Neoflow continuous flow reducing camera for engineering drawing reproduction. The unit is said to save reproduction materials, save shipping costs, save filing space, speed print production and assembly operations.

522 BRASS MILL PRODUCTS

Bridgeport Brass Co.—A 170-page illustrated handbook on brass mill products covers copper-base alloys, strip and sheet, rod and wire, tubing, metalworking, and contains tables, measurements and historical data.

523 RECORDER

Leeds & Northrup—A 44-page technical publication illustrates and describes recorders which provide more than 2300 variations of measuring circuits, each developed for applications to certain types of measuring problems. The variety of measuring circuits are described, along with the unit's balancing system, and types of instruments available.

524 PLASTICS, FIBERS

Spaulding Fibre Co., Inc.—An eight-page booklet lists mechanical, electrical and chemical properties, specific applications of fabricated parts, general applications and applications classified by industries of plastics and fiber products.

525 NONFERROUS CENTRIFUGAL CASTINGS

Shenango-Penn Mold Co.—Four-page Bulletin 154, printed on heavy paper, provides a table of minimum physical properties, nominal chemical analyses, and comparative specification designations for 35 Shenango nonferrous alloys.

526 TECHNICAL BOOKS FOR ENGINEERS

Ronald Press Co.—Brochures containing detailed descriptions of current technical books on mechanics, engineering, aeronautics, industrial management, metallurgy, applied and physical sciences, etc. Practical reference works like the Ronald Handbooks, basic studies, and pioneering works on the latest engineering and scientific developments are included.

527 HIGH TEMPERATURE ALLOY

Firth Sterling, Inc.—Literature covers specifications of three high temperature alloys for aeronautical use. Composition, general characteristics, typical applications, forging, general heat treatment, corrosion resistance, welding properties, machinability, physical constants, tensile properties. Hardness values and fatigue values are included for each metal.

528 VERTICAL TURBINE PUMPS

Layne & Bowler Inc.—A 4-page bulletin illustrates and describes vertical turbine pumps for industrial and municipal primary water supply. Cutaway photos show the pump features and a section of the bulletin gives background on the company's engineering and manufacturing facilities.

529 RUBBER, PLASTICS PRODUCTS

General Tire, Industrial Products Div.—Catalog No. 786 gives basic specifications and application data on molded and extruded rubber products and extruded, polyvinyl chloride, polyethylene and modified pvc.

530 STEAM DISTRIBUTING TUBE

John J. Nesbitt, Inc.—Catalog 305-1 illustrates and describes new series T steam distribution tube type heating surface employing the principle of two steam passes in each distributing tube to eliminate stratification under modulated steam control. Each tube serves two adjacent condensing tubes.

531 MECHANICAL CONSTRUCTION

Dravo Corp., Machinery Div.—"Engineering Constructors," catalog No. 1200, describes the company's mechanical construction services. Prepared as a photographic story, the book shows typical examples of construction projects completed for steel mills, chemical plants, water works and the petroleum industry. Introduction explains how a staff of experienced engineering-construction specialists are equipped to consummate any type of working contract.

532 STEAM, AIR TRAPS

C. E. Squires Co.—A four-page bulletin covers steam and air traps for pressures to 600 psig. Cutaway photos show features and flow capacities are tabled. Accessory equipment is listed.

533 CONTROL SYSTEMS

Daytronic Corp.—A 6-page folder illustrates and describes linear variable differential transformer measurement and control systems for indication and recording, automatic control, alarm or safety shutoff, oscillographic studies. A discussion of LVDT operating principles is included.

534 PRECISION CASTINGS

Crucible Steel Co. of America—A 16-page bulletin covers precision investment castings. The company's facilities are illustrated and described, and properties and composition of the castings are included.

535 TECHNICAL BOOKS

The American Society of Mechanical Engineers—1956 Catalog of ASME Publications is a 20-page descriptive price list of current books, standards, codes, research reports, and periodicals published by the Society.

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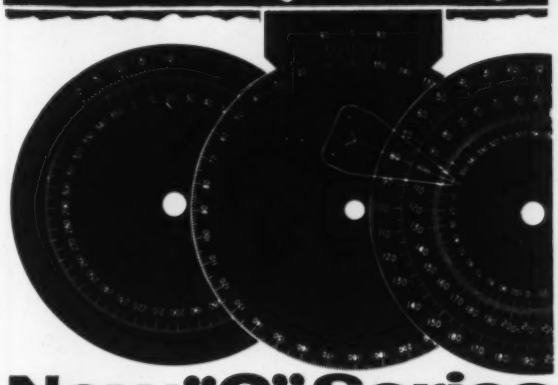

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LATEST INDUSTRIAL LITERATURE

536 TEMPLATES

Jergens Tool Speciality Co.—A portfolio contains 48 tracing templates for strap clamp assemblies, malleable and aluminum hand knobs, speed handles, speed bar knobs, revolving clamp assemblies and swing clamp assemblies.

537 VENTILATED CLUTCH

Fawick Airflex Div., Fawick Corp.—Bulletin ML-102-A illustrates and describes a completely ventilated clutch design and built for heavy duty service. Diagrams and dimension tables are used to show the various series of clutches available.

538 STEAM CONDUIT

Stillwater Clay Products Co.—An engineering manual on steam conduit covers specifications, design, construction, insulation and installation of conduit over a wide range of applications.

539 HEATING EQUIPMENT

Iron Fireman Mfg. Co.—A 60-page booklet covers engineering data on oil, gas and coal fired heating and power equipment. It is designed, not as a service manual, but to provide architects and engineers with information for better understanding the problems of fuel handling.

540 EXPANSION JOINTS

Solar Aircraft Co.—Catalog 66, 16 pages, covers Solar's convoluted couplings in nominal pipe size from 1/2 to 72 in. Couplings are designed to accomodate axial movements only, or axial and combination movements. Formulas for calculating various movements of the couplings are included.

541 SPEED VARIATOR

Cleveland Worm & Gear Co.—Bulletin K-22 illustrates and describes a speed variator that provides indefinitely variable output speed over a range up to 9:1 from a constant speed power source. Operating characteristics, diagrams and cutaway drawings are included.

542 FIRED INDIRECT HEATERS

Brown Fintube Co.—Bulletin No. 551 covers the applications, advantages and types of fired indirect heaters for air, special atmospheres, corrosive and non-corrosive gases, thermal chemicals, circulating oils, asphalt, and for super heating vapors.

543 AUTOMATIC CONTROLS

Assembly Products, Inc.—Bulletin G-7 illustrates and describes automatic controls for heat, speed, radiation, voltage, current, pH in industrial applications. The units are described as particularly adaptable to automation applications.

544 TEFLON MOLDINGS

Sparta Mfg. Co.—A 4-page flyer describes molded Teflon in thin sections and shapes, such as cup, ball, or shaft seals, washers, gaskets, and diaphragms. A table of properties is included and typical products illustrated.

545 TUBE EXPANDERS

Gustav Wiedeke Co.—A bulletin features package boiler, water tube boiler and condenser tube expanders. Diagrams show typical applications and construction details of the units.

546 CHUCKING MACHINES

National Acme Co.—Bulletin CM-51A illustrates and describes 4, 6 and 8 spindle chucking machines in capacities ranging from 5 1/4 to 12 in. Construction features are shown in cutaway drawings. Specifications and dimensions are tabled.

Your NEW CATALOGS Guide offers readers of MECHANICAL ENGINEERING an opportunity to secure advertisers' latest industrial literature available. In this issue there are 546 items to make selections from. For convenience an index may be found on pages 43 and 44. Select desired catalogs by number, requests limited to 25 catalogs. Fill in coupon on page 44 and mail promptly. (*Must be mailed on or before date given on coupon.*)

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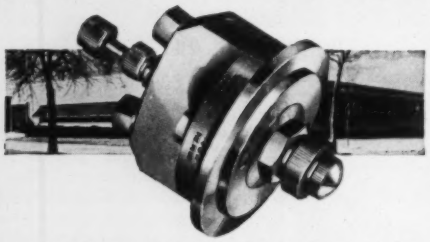

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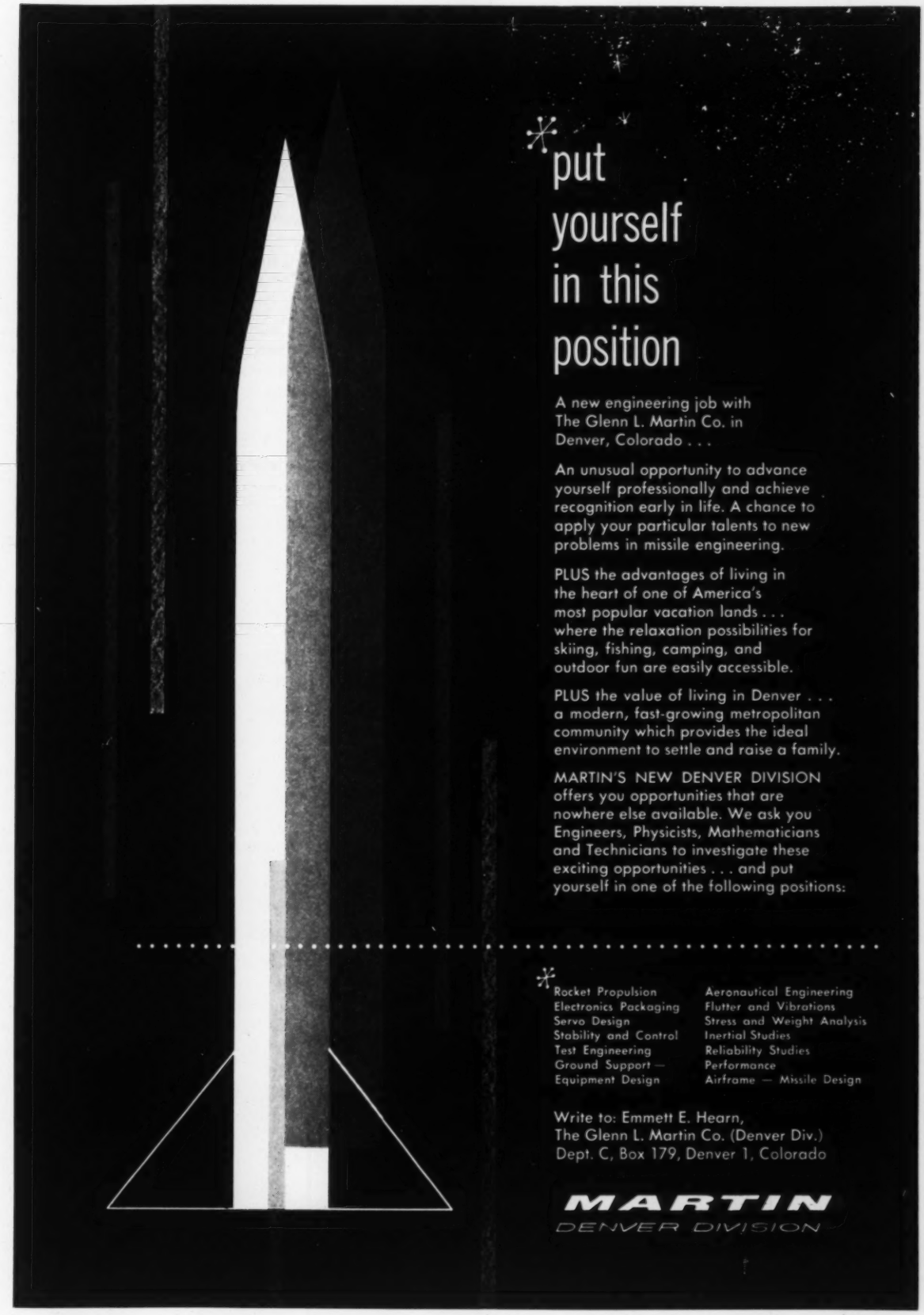
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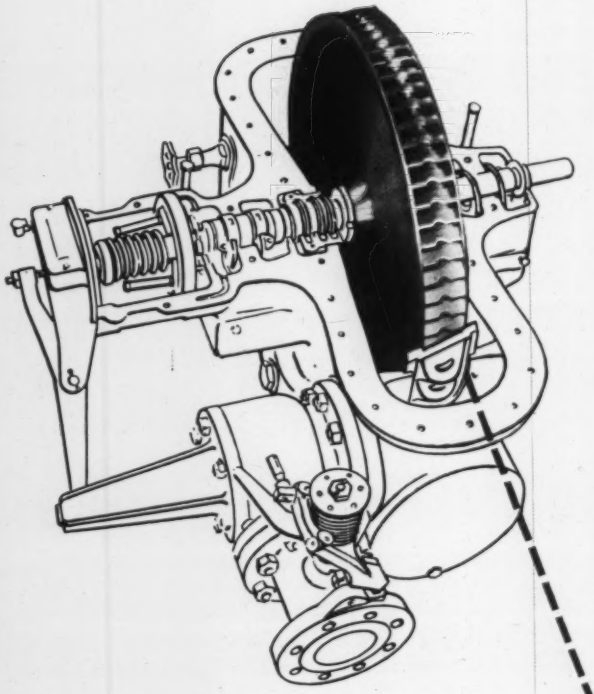
Work Horse of Industry..since 1906



The Terry Steam Turbine Company was incorporated in 1906 to manufacture *a workable and efficient prime mover that would operate with minimum maintenance.* This prime mover was the solid-wheel turbine, which had been invented by Edward Clinton Terry a few years before.

Although maintenance practice has improved vastly since then, the demand for the turbine has multiplied many times. *Rising maintenance costs have actually increased the need for trouble-free operation.*

Today, there are more Terry solid-wheel turbines in operation, and there are more built each year, than ever before. The explanation is simple.

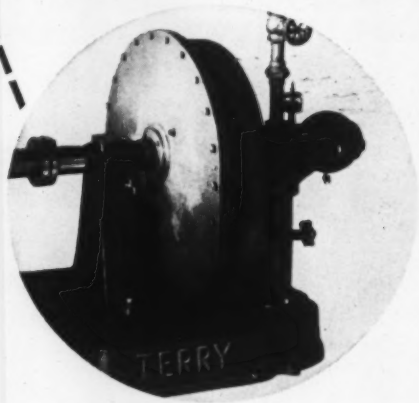
Here is a turbine with a virtually indestructible wheel. Made of a single forging of special composition steel, there are no separate parts to loosen or work out. As the only function of the blades is to form a series of pockets, any wear which may occur does not materially affect horsepower or efficiency.

Blades will not foul. They have large clearances and are further protected by the projecting rims at the sides of the wheel. As the side clearances are also very large, end play can do no harm.

These are a few of the reasons why the Terry solid wheel turbine has been the *work horse of industry — since 1906.* For the full story, send for a copy of Bulletin S-116.

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD 1, CONN.

TERRY



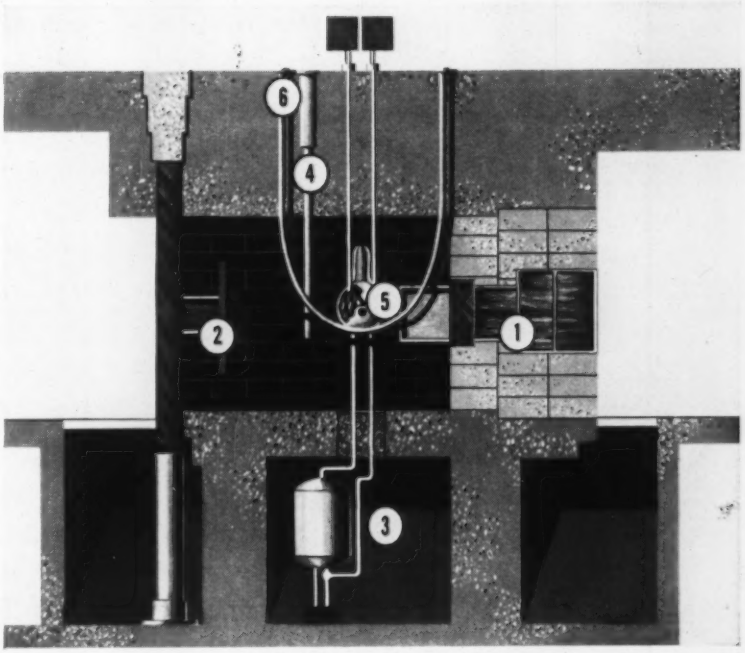
1906 was the year this turbine was built in Terry's plant. It is believed to be one of the first small direct-connected turbines built for commercial use in the United States.

TT-1203

NUCLEAR NEWS FROM ATOMICS INTERNATIONAL

Nuclear Reactor for Cancer and Other Medical Research

This new reactor utilizes the proven homogeneous solution design based on the SUPO unit at Los Alamos—modified and adapted to the special needs of cancer and other medical research and therapy. To be built by ATOMICS INTERNATIONAL for a prominent southern California university Medical Center, the reactor will provide a variety of radiological facilities—primarily high purity neutron and gamma beams with controlled exposure times in each. The thermal neutron flux at the central exposure tube is 1.7×10^{12} n/cm²-sec. at a power of 50 Kw.



Medical Reactor Test Facilities

1. Gamma and Fast Neutron Facility—Gamma intensities of 1.3 reb/min/Kw and fast neutron intensities of 4 reb/min/Kw are available.
2. Thermal Neutron Facility—Provides neutron flux of 3.8×10^7 n/cm²-sec. per kilowatt.
3. Gamma Radiation Area—Activity of the fission gases provides a radiation source in the gas handling equipment room.
4. Multiple Specimen Irradiation Tube—One or more in the reflector. Each accommodates 16 samples.
5. Central Exposure Tube—A 1-inch internal diameter tube through the center of the core permits access to maximum neutron flux.
6. Pneumatic Tubes—Tangential to core. Also (not shown) are Beam Tubes—Radial to core, or through reflector tangential to the core.

Gas handling system assembly for nuclear research reactor. This component, developed by Atomics International, contains facilities for circulating the reactor atmosphere, recombining the radiolytic gases, condensing the water vapor and returning water to the reactor core, in a closed cycle operation. Additionally, the tank at top which contains fission product gases, provides an intense source of neutron-free gamma radiation.

One Configuration of the thermal neutron facility provides a neutron flux of 3.8×10^7 n/cm²-sec/Kw with a gamma ray intensity of only 0.1 reb/min./Kw (reb—roentgen equivalent biological). The fuel is Uranium enriched in the U^{235} isotope in the form of UO_2SO_4 dissolved in light water. This fuel-moderator solution, cooled by chilled recirculated water, is contained in a stainless steel core tank surrounded by a graphite reflector and dense concrete shield. Radiolytic and fission gases produced in operation are handled in a closed-cycle, water recombination and return system, which eliminates any discharge of radioactive core effluents and permits the re-utilization of materials.

Atomics International is a major reactor builder—experienced in the design, construction and operation of nuclear reactors for research and the production of power. If you are interested in any phase of our activities, ATOMICS INTERNATIONAL is staffed and equipped to help you. Please write: Applications Engineering Service, Dept. ME-N1, ATOMICS INTERNATIONAL, P.O. Box 309, Canoga Park, California. Cable address: ATOMICS.

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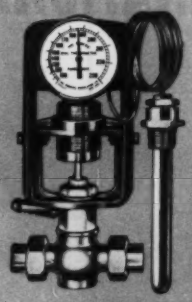
WHY POWERS No. 11 REGULATORS Give BETTER CONTROL and Last Longer



TEMPERATURE Indicating Regulator with Single Seat Valve

Better TEMPERATURE Control results from powerful bellows and minimum of valve stem friction. Valve Stem Lubricator aids easy movement of valve stem without binding. Double ply metal used in Powers bellows outlasts ordinary single ply type.

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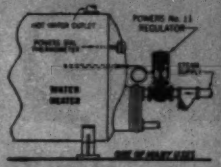

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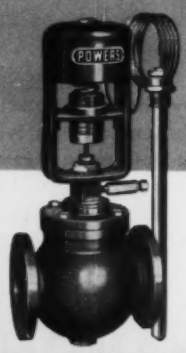
EASY TO INSTALL bronze union connections for single and double seat valves thru 2" save installation time and labor.



(c44)

Above: Flanged Iron Body Valve with Double Seat for sizes above 2"

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● Right type of Regulator and the right size valve is important for best control. From Powers complete line of self operating regulators and air operated temperature controllers you can be sure of getting the type best suited for your requirements. Call our nearest office or write us direct. 3400 Oakton St., Skokie, Illinois. Offices in Chief Cities.

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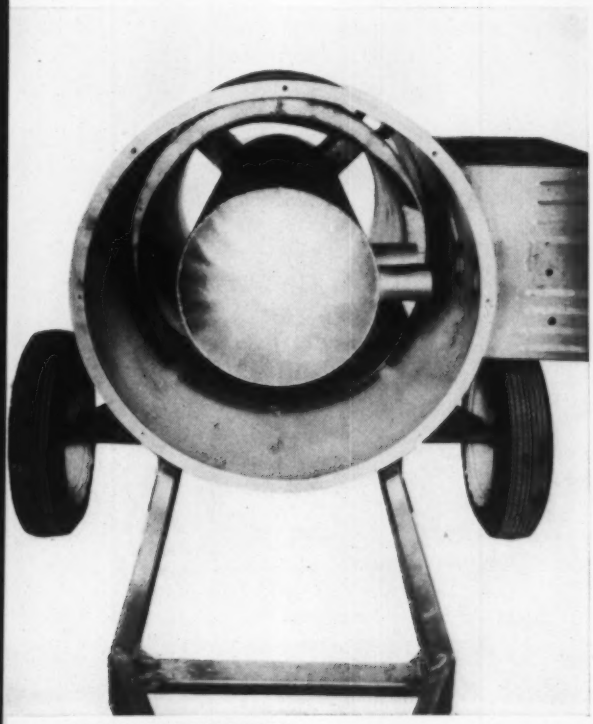
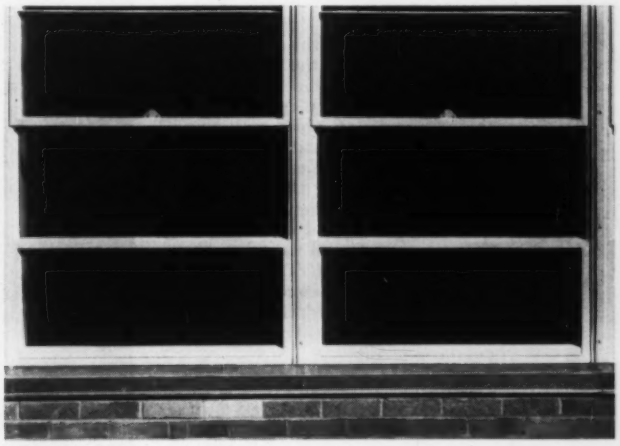
THE POWERS REGULATOR COMPANY

FOR TRAILERS THAT DO NOT WEAR OUT. This Fruehauf trailer has sides made from thin sheets of Stainless Steel, corrugated into walls that are only one inch thick. That's why it can carry more cargo than trailers of other, heavier types of construction. Most joints are welded, an easy job with Stainless. There is nothing to corrode or loosen; in fact, no Stainless trailer has ever worn out!

NOTHING *can equal Stainless Steel*



FOR HEAT RESISTANCE. This is a Lennox Crop Dryer. It burns 12 gallons of fuel oil per hour and has an input of 2,000,000 BTU. Wherever the heat is most intense, type 430 Stainless Steel is used. It is especially important for the combustion chamber and emitting tubes.



FOR ARCHITECTURAL USE. This Dawson Floating Sill is made from type 302 Stainless Steel. It combines fine appearance with the enduring properties of Stainless Steel. The finished job is neat and trim, and it will last as long as the building.

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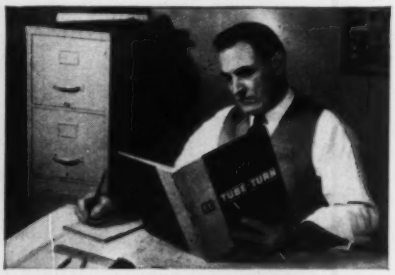

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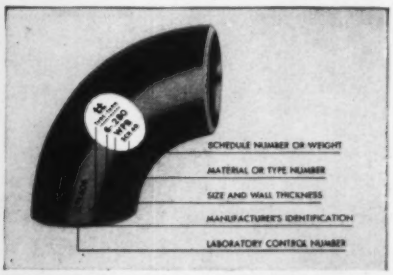

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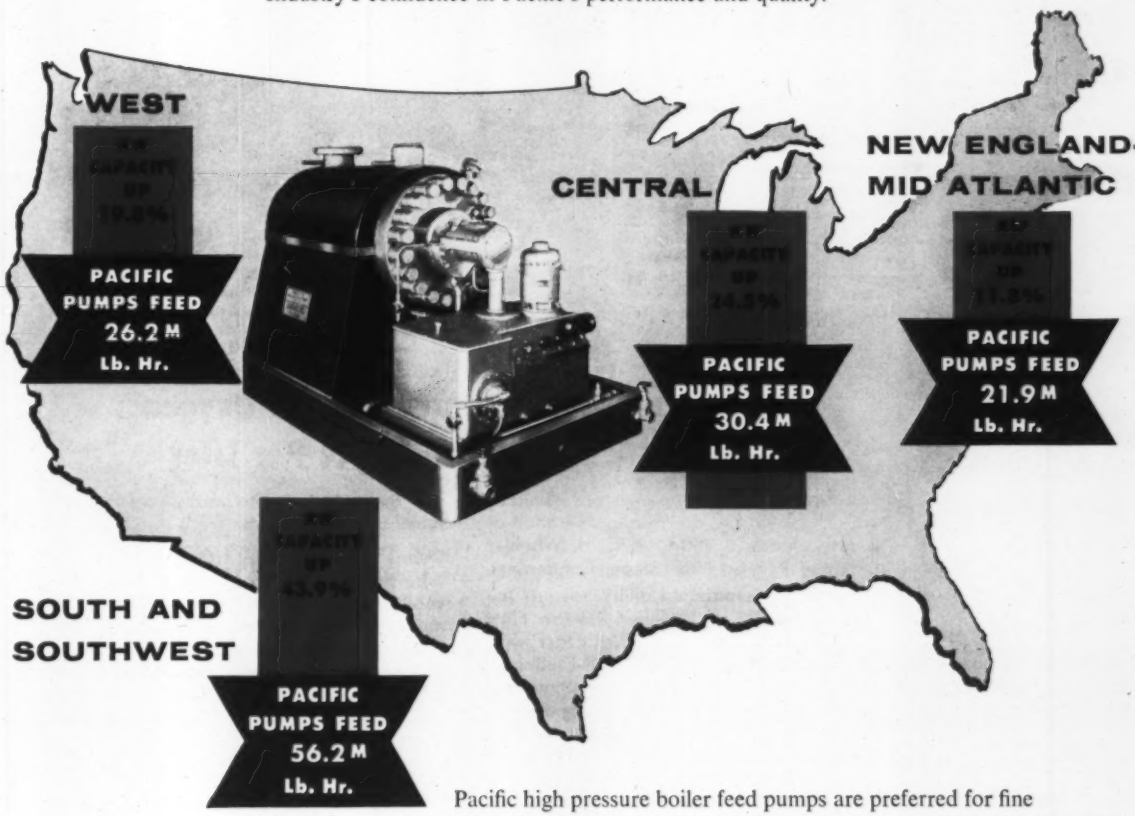
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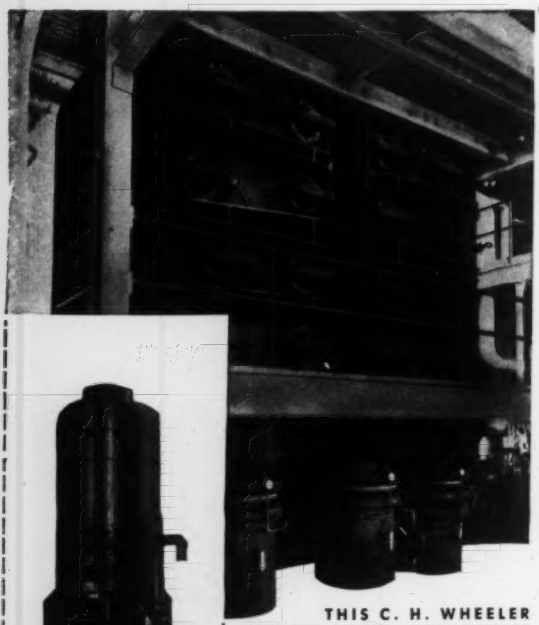

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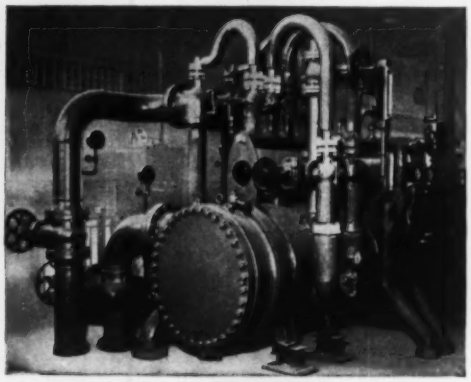

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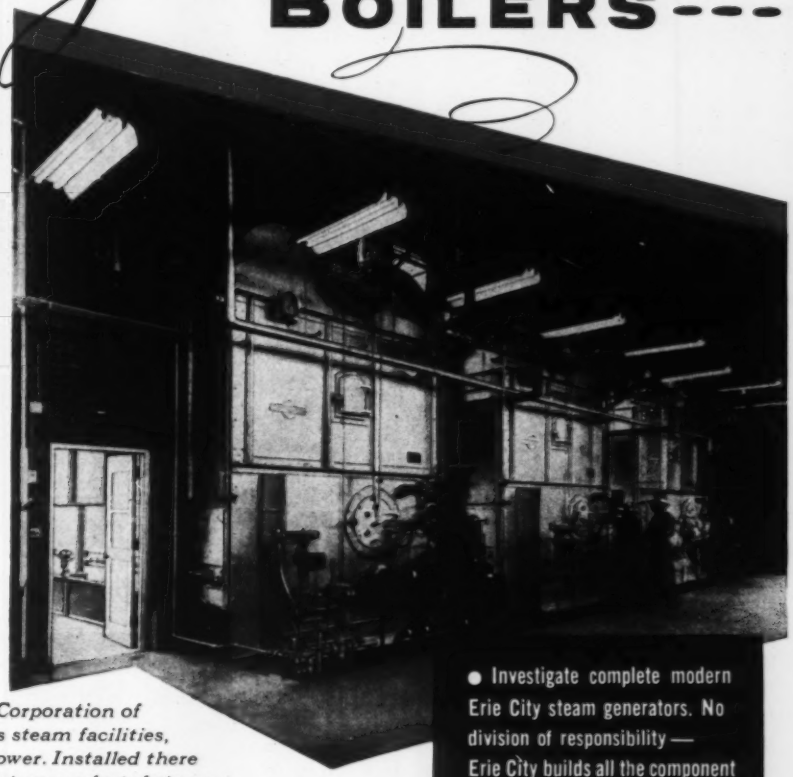

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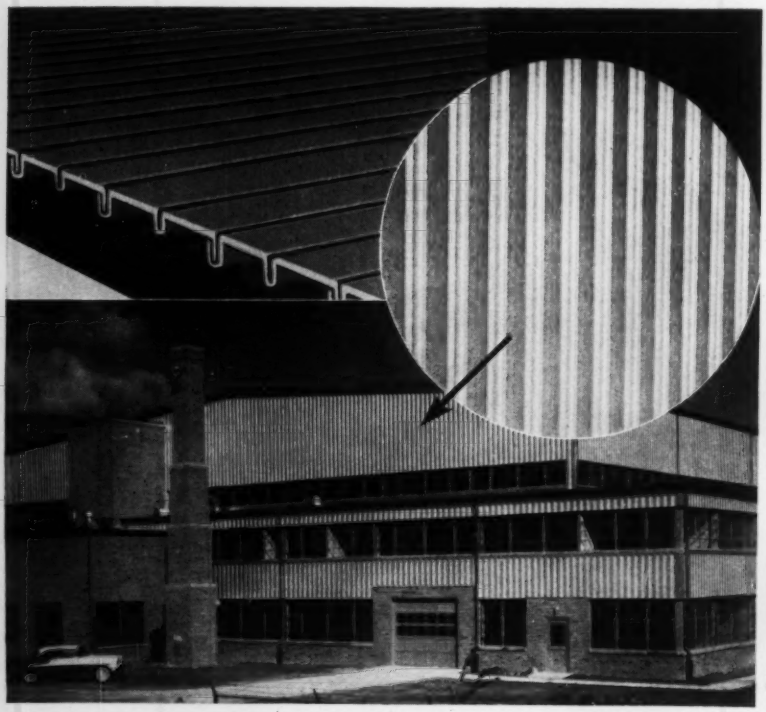

(TOP) *Cross-section of cold-roll-formed Roof Deck by Walker Supply & Mfg. Co., Ecorse, Michigan.*

(INSET CIRCLE) *Aluminum siding panels, (made by Walker Supply & Mfg. Co.) give fine architectural effect.*

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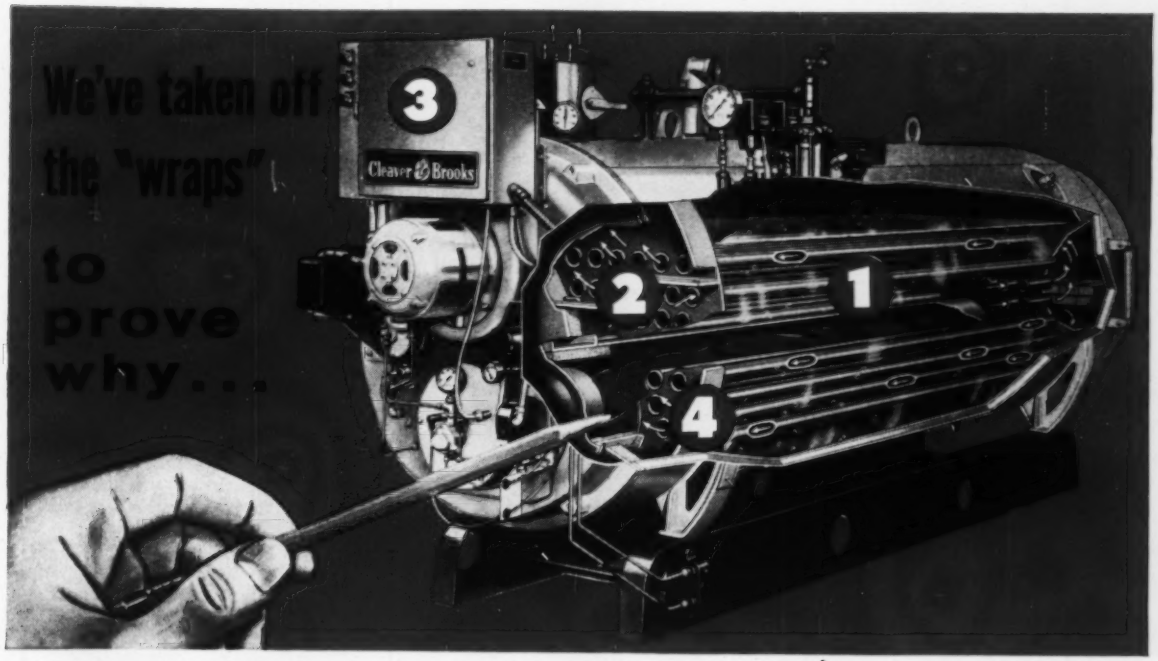

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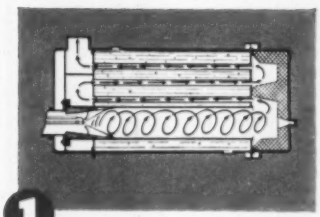

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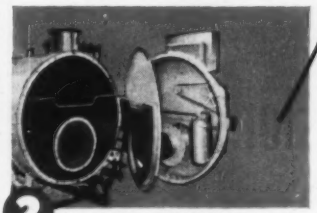
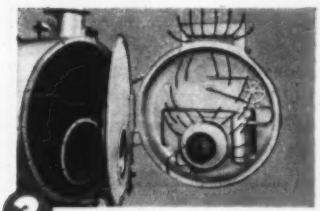
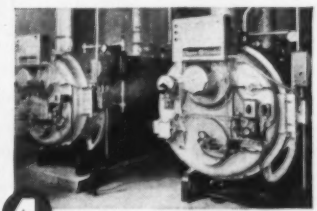


2 **Hinged doors front and rear —** Expose tubes for quick inspection or cleaning. Operating equipment and refractory stays intact. Cuts routine maintenance from hours to minutes. Doors are gasketed with preformed asbestos to be seal-tight.



3 **Caseless fan keeps operation "hospital quiet" —** Air is drawn into a large plenum chamber which confines and deadens air noises. Even at peak loads, CB is well within requirements for low sound levels where this is a factor.



4 **Automatic controls are centralized for convenience, efficiency and safety —** Air is metered with oil (or gas) in proper ratios to economize on fuel. Electronic flame failure control is standard equipment.

CB boiler's remarkable performance in hundreds of applications has proved an "eye-opener" wherever installed. Take a minute's time and see why.

Combined into one boiler package are all the features *proved necessary* to: (1) save fuel dollars, (2) simplify maintenance, (3) assure silent performance, (4) maintain safe, automatic operation.

Talk to your nearby Cleaver-Brooks boiler representative — he can assist you in selecting the proper unit from a complete line of sizes, steam or hot water, 15 to 250 psi. Or, write direct for literature. Cleaver-Brooks Company, Dept. D, 318 E. Keefe Ave., Milwaukee 12, Wis., U.S.A. Cable Address: CEEBEEWEST — all codes.

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This is a working session of some of the country's best scientific and engineering minds. Their assignment: develop, design and construct atomic power plants for a fleet of ships. Where are they? At Bettis Plant, Pittsburgh, operated by Westinghouse for the AEC. This is the largest design and engineering center for atomic power plants in the country. Here the power plants for an atomic fleet are actually being designed and built.

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Activity at Bettis Plant is expanding because more power reactors are being built here than at any other place.

Atomic experience is *not* required. Write for a descriptive brochure describing opportunities in your field. Be sure to indicate your specific interests. Mr. A. M. Johnston, Westinghouse Bettis Plant, P. O. Box 1468, Dept. A-14, Pittsburgh 30, Pa.

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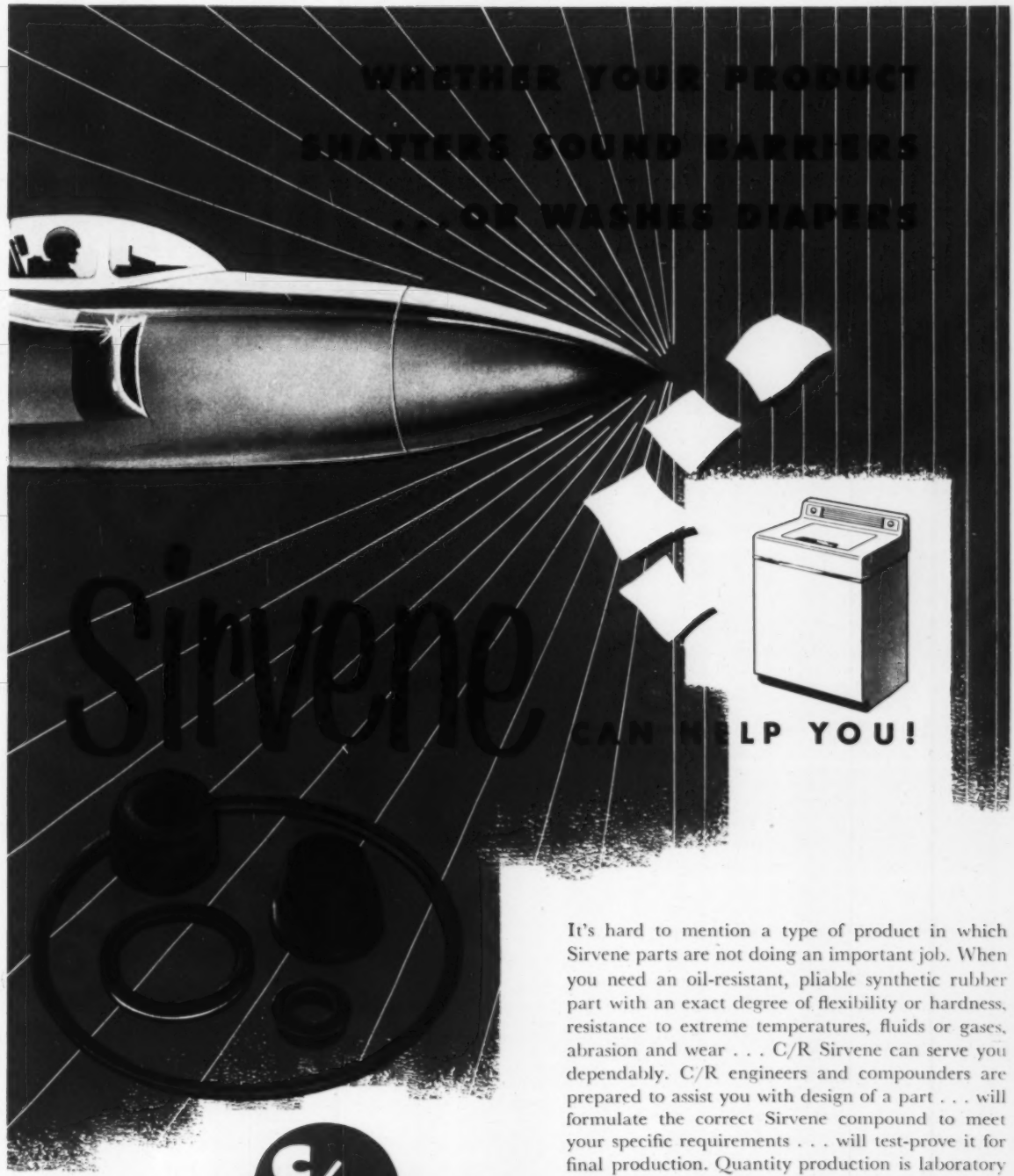

It's hard to mention a type of product in which Sirvene parts are not doing an important job. When you need an oil-resistant, pliable synthetic rubber part with an exact degree of flexibility or hardness, resistance to extreme temperatures, fluids or gases, abrasion and wear . . . C/R Sirvene can serve you dependably. C/R engineers and compounders are prepared to assist you with design of a part . . . will formulate the correct Sirvene compound to meet your specific requirements . . . will test-prove it for final production. Quantity production is laboratory controlled, assuring you of constant quality and uniformity. Write us for your copy of the new "Sirvene" brochure.

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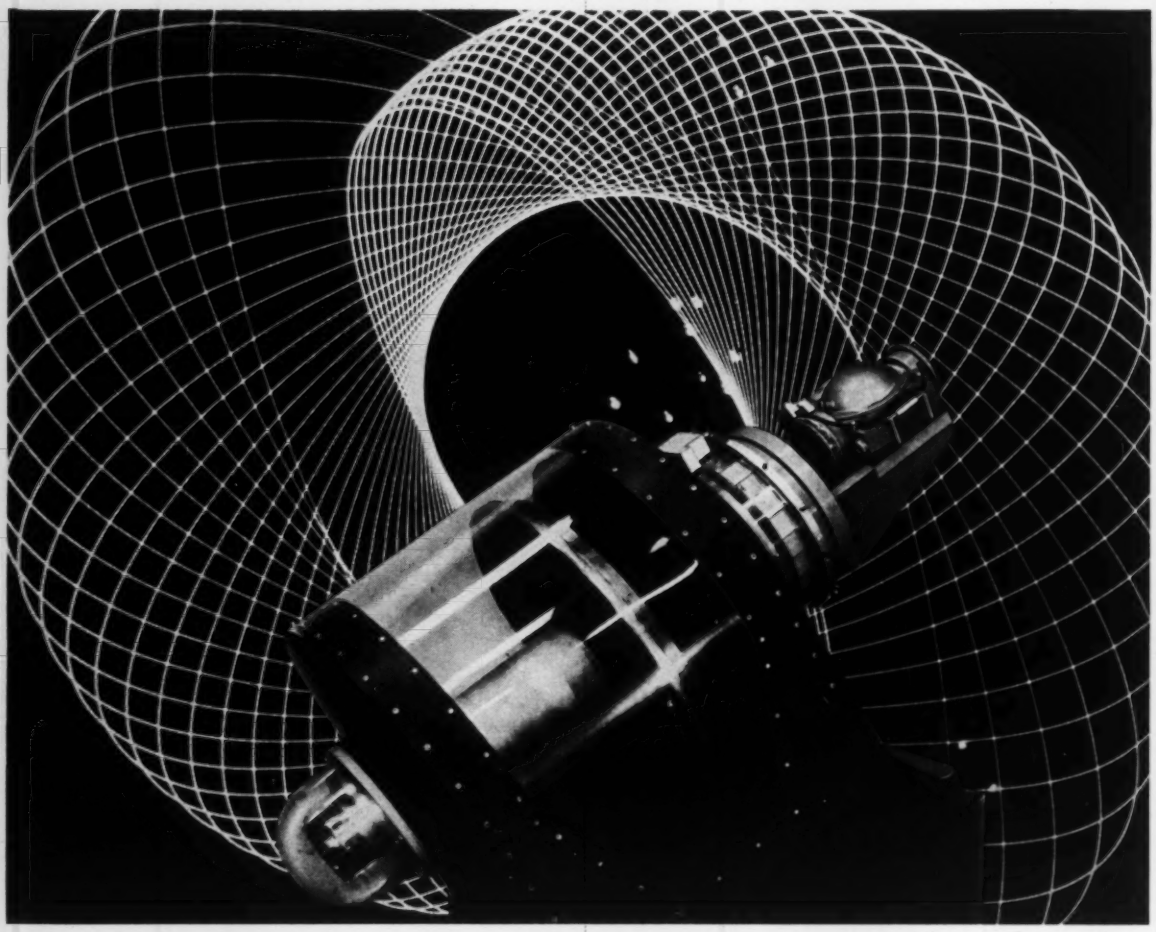

$$\bar{r}(t) = \int_0^t (t - \tau) \left[\frac{d^2\bar{r}}{d\tau^2} - \bar{\omega} \times (\bar{\omega} \times \bar{r}) - \frac{d_r\bar{\omega}}{d\tau} \times \bar{r} - 2\bar{\omega} \times \frac{d_r\bar{r}}{d\tau} \right] d\tau$$

$$\bar{L} = \frac{d_r}{dt} (\bar{\bar{I}} \cdot \bar{\omega}) + \bar{\omega} \times (\bar{\bar{I}} \cdot \bar{\omega})$$

People who write ads are not supposed to know a great deal about equations like these, and frankly we don't. But we have the feeling *you* recognize them as basic to the development of inertial guidance systems. More specifically, we understand they are the vector equations which, in effect, must be mechanized through the use of either digital or analog techniques.

AUTONETICS, a division of North American Aviation, Inc., has been implementing these and other mathematical truths for more than 10 years. This work is in the hands and minds of the engineers and scientists in our 2,200-man engineering department. They have achieved outstanding results in producing complete guidance systems for airplanes and missiles. Also, important precision elements of such systems have been developed through a complete understanding of these and other equations.

AUTONETICS has complete facilities for the research, development, design flight test and manufacture of inertial guidance systems... as well as autopilots, armament controls, computers and special products.

If your professional interest is stimulated by this advertisement, and you would like to know more about AUTONETICS — please write: AUTONETICS, Dept. ME-N, 12214 Lakewood Blvd., Downey, California.

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It may surprise you to know you can qualify for a career at ROCKETDYNE *with or without specific rocket engine experience!* Engineering experience in heating and ventilating, hydraulics, pumps, turbines, combustion devices, controls, dynamics, structures and instrumentation are just a few of the related fields that could open your future at ROCKETDYNE.

ROCKETDYNE's design and manufacturing center and its nearby test laboratory house complete, advanced facilities... the vital tools you need to meet the challenges of rocket engine development.

ROCKETDYNE is North American's rocket engine division. It has just moved into new ultra-modern headquarters in Canoga Park, located in the beautiful West San Fernando Valley of Los Angeles. This area is famous for its fine residential sections, modern shopping-center convenience, varied recreational and entertainment facilities. Any point in the San Fernando Valley is just minutes drive from the beaches, and the weather is pleasant all year around. Many engineers are interested in advanced courses offered by fine schools like UCLA, USC and Cal Tech, all within a short drive from our headquarters.

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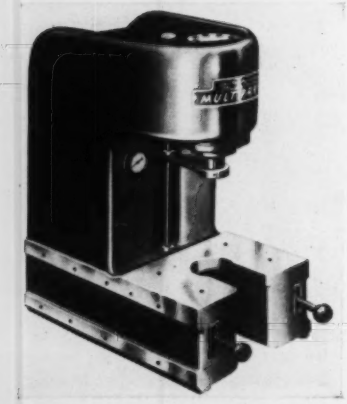

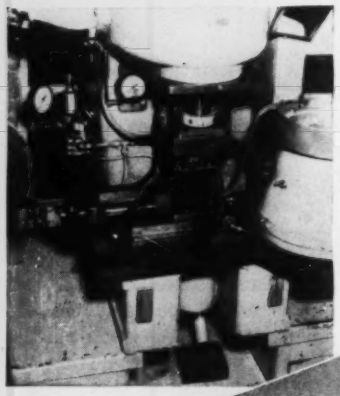

100 assemblies per minute . . . that's the production turned out by one Denison Multipress at International Business Machine Corporation, Poughkeepsie, New York.

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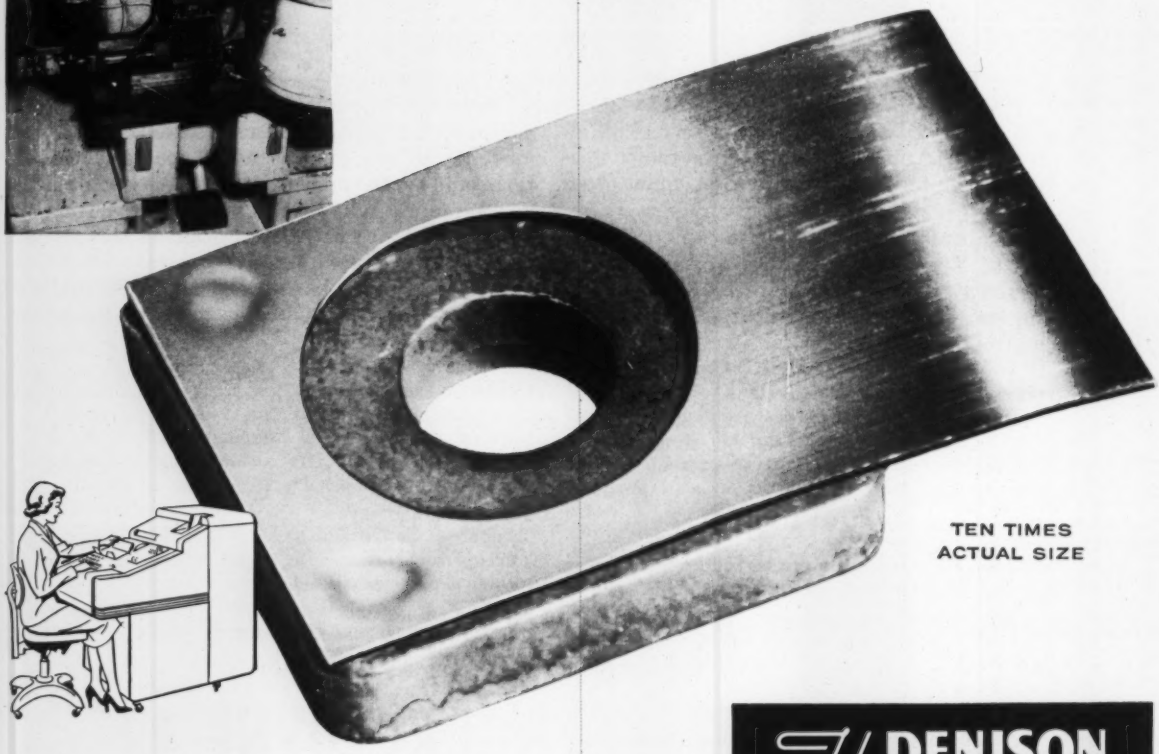

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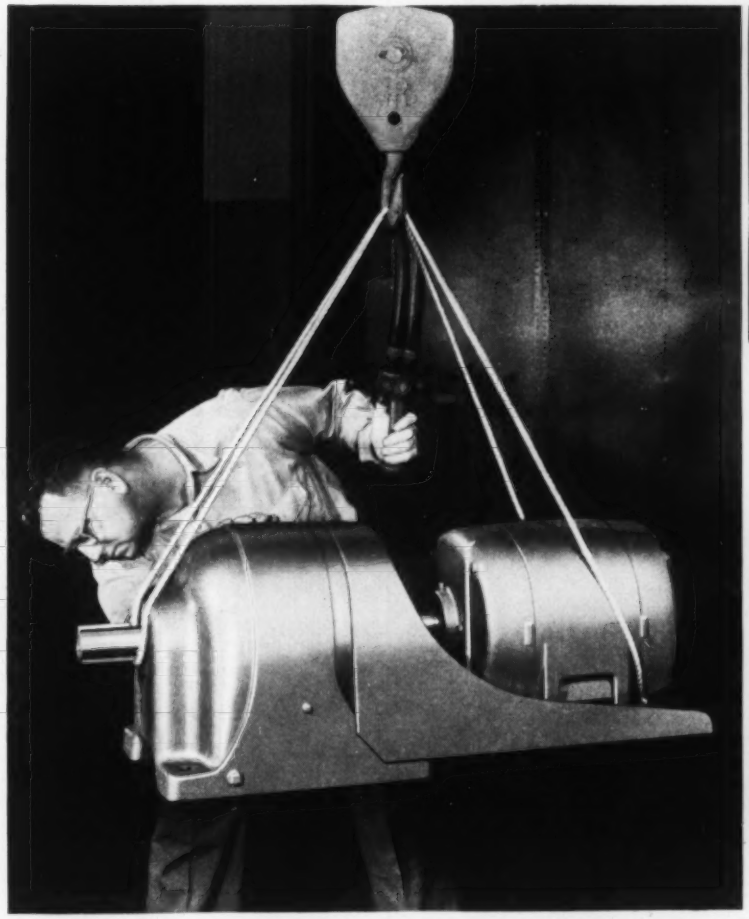

THE NEW LINK-BELT MOTOGEAR — for bracket-mounting all makes and enclosures of foot-type NEMA motors — offers widest application flexibility. To change motor, you simply remove four bolts, separate the coupling. No need to drain oil in housing.

IN-LINE HELICAL GEAR DRIVES are your answer if you already have motors, your machinery is equipped for mounting motor and drive, or if motor and drive will be connected by chain, belt or gears. Speed reductions to over 100 hp described in new Book 2651.

LINK-BELT GEARMOTOR is foremost in compactness — maintains positive, permanent alignment with flange-mounted NEMA motors. New Book 2447 describes Gearmotors up to 30 hp, speeds from 280 down to 6 rpm — Motogears up to 60 hp, ratios from 6.2:1 to 292:1.

The 'Motogear' moves into industry

as part of the new Link-Belt line of compact enclosed drives

ULTIMATE in flexibility, all-new Link-Belt Motogears offer improved service where motor speeds must be reduced in a fixed ratio. Together with the new Link-Belt Gearmotors and In-Line Helical Gear Drives, they fully utilize the compactness of the new NEMA motor sizes of any manufacturer.

In addition, Link-Belt offers a significant step toward standardization. All three drives have one low-speed gear set per drive size. Hardened gears and a minimum number of parts results in less wear and quieter operation. Another advance is rugged housing construction — of sound-absorbing cast iron with oil-tight design.

However large or limited your use of speed reducers, you may be able to make significant savings in your maintenance and production costs with these new drives. Write LINK-BELT COMPANY, Dept. AV, Prudential Plaza, Chicago 1, Ill.

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BROWN BOVERI GAS TURBINES

NON-REGENERATIVE CYCLE with 25% FIELD-TESTED EFFICIENCY

A 25,000 kW Brown Boveri Gas Turbine installed for Societa Selt Valdarno at Livorno, Italy, for peak load service using Bunker C oil. Proven tested efficiency of 25%. Non-regenerative cycle. Operating temperature on the gas side, 1200°F. insuring long life and low maintenance. Another identical unit goes into operation in May 1956.

WITH a proven-in-actual-operation efficiency of 25%, Brown Boveri Non-Regenerative Cycle Gas Turbines are setting new standards for performance and economy. This operating experience with large turbines — even those fired with low-grade gas or oil — can be found only in Brown Boveri Gas Turbines.

In first costs, these turbines show marked savings. They cost substantially less than comparable conventional steam turbine plants.

If you are concerned with large output gas turbines, it will pay you to investigate Brown Boveri equipment.

Other Recent Orders for identical 25,000 kW Brown Boveri Non-Regenerative Cycle GAS TURBINES

- **Societa Romana di Electtricita for Roma 1 (Italy) Power Station**
- **Gullspong Munksfors Kraft AB Oerebro for Otterbacken Power Station**
- **City of Edmonton, Canada, Power Plant, 2 units**
- **City of Vancouver, Canada, Power Plant, 3 units**
- **City of Joarcan, Canada, Power Plant, 1 unit**

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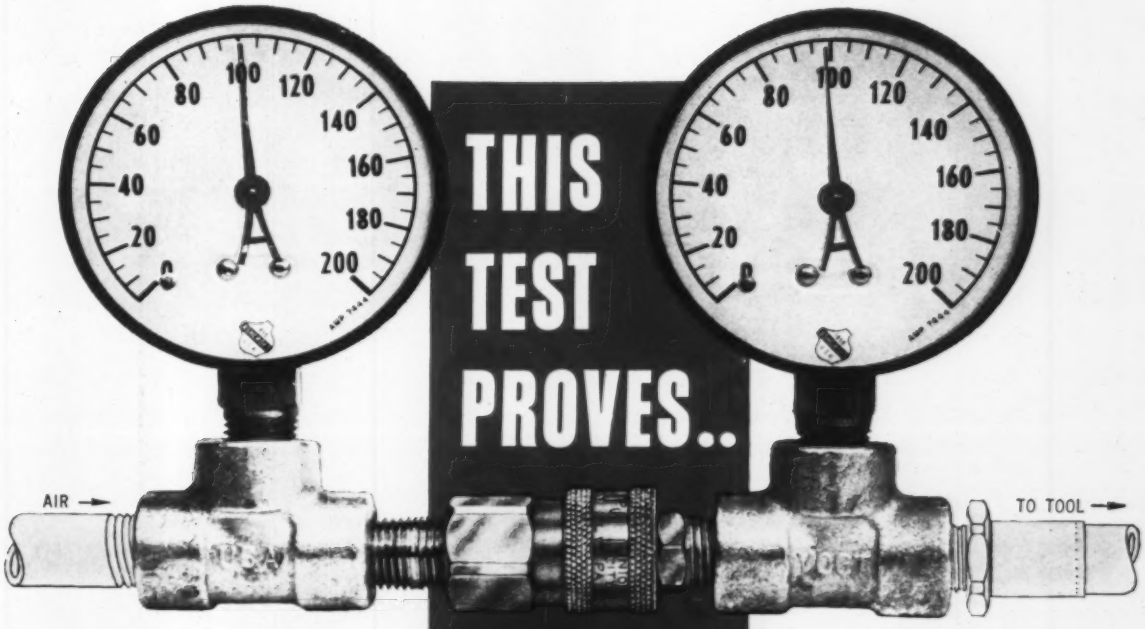


Snap-tite's quick-connect "Hi-Flow" coupling delivers maximum flow with minimum pressure drop

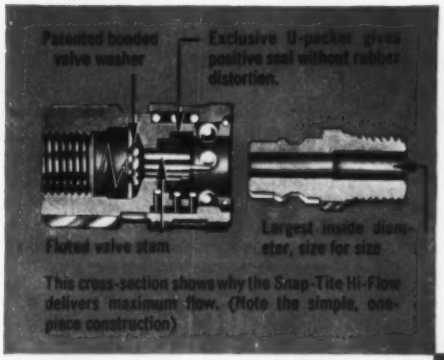
What this test can mean to you

Air tools are designed to operate most efficiently at 90 psi. For every 10 pounds of pressure drop under 90 psi your air tools lose 13% speed and power. If air pressure at your tools is below 90, in spite of a higher reading at your compressor, there are two corrective measures you can take:

One: overwork the compressor to overcome excessive pressure drop of your present couplings . . .

Or Two: install Snap-Tite "Hi-Flow" couplings at each air tool.

Tests run in plants all over America prove "Hi-Flow" couplings lose far less air pressure than any other quick-connect coupling.


Patented bonded valve washer
Exclusive U-packer gives positive seal without rubber distortion.
Fluted valve stem
Largest inside diameter, size for size
This cross-section shows why the Snap-Tite Hi-Flow delivers maximum flow. (Note the simple, one-piece construction)

COMPARE QUICK-CONNECT COUPLINGS

You can set up this quick-connect coupling test in 5 minutes in your plant . . . better still, let your Snap-Tite representative show how really efficient quick-connect couplings increase production and maintenance efficiency in your plant. WRITE

Snap-tite

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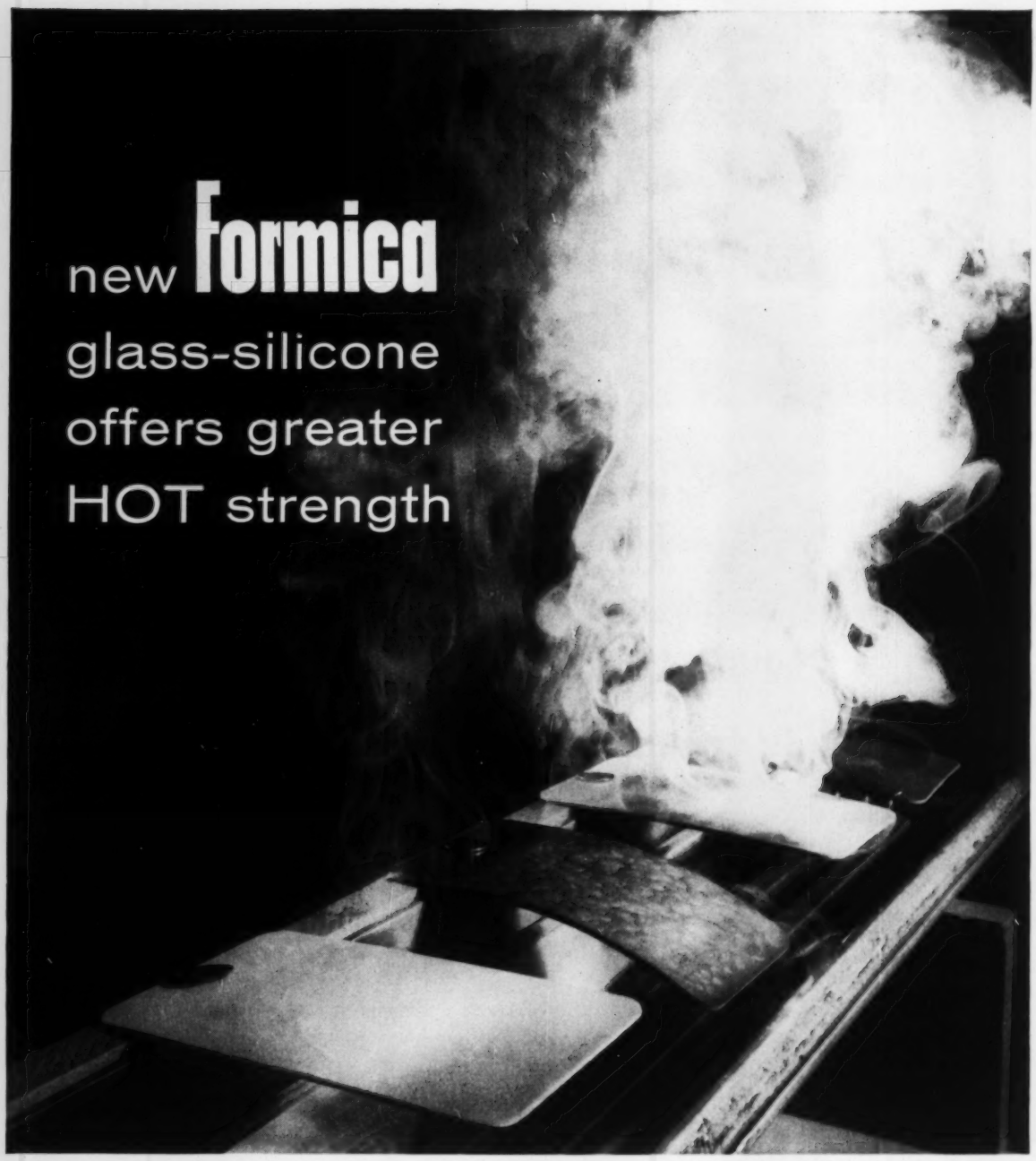

New Formica G-7-2 silicone offers five characteristics for broader application:

1. Greater hot strength.
2. Lower moisture absorption (.12% after 24 hrs. immersion).
3. Lower wet power factor (.008).
4. Larger and thicker sheets (up to 36″ x 72″ x 2″).
5. Uniform creamy white color.

The photo above dramatically demonstrates the outstanding hot strength property of Formica's new G-7-2. A withering blast from the lab heater causes three ordinary laminated plastics to smoke, char, blister and bend. But G-7-2 comes through this grueling test unmarked, its mechanical and electrical properties virtually unaffected.

G-7-2 is approved under military spec MIL-P-997-B, type GSG.

The unusual properties of G-7-2 are especially useful in guided missiles, radar, radio and tv, motors and generators and other electrical/electronic applications. Recommended for printed circuitry. For complete information, send today for free G-7-2 data sheets. The Formica Co., 4611 Spring Grove Ave., Cincinnati 32, O.

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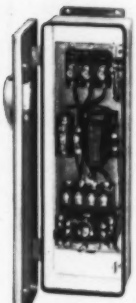
A New Line

OF BULLETIN 712 COMBINATION STARTERS

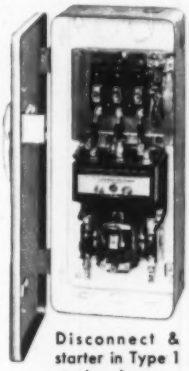
Allen-Bradley announces a modernization of its Bulletin 712 combination starters that should meet with the instant approval of plant "safety" organizations. The cover cannot be opened unless the operating lever is in the "off" position; also the movable disconnect contacts are **plainly visible** when this switch is "open." A welded or sticking contact can be detected instantly. The new operating lever contains a concealed latch pin which permits the maintenance man to open the cabinet without opening the disconnect and stopping the motor. Disconnect switch can be padlocked with three locks—in the open position. It can be arranged for padlocking in running position.

SIZE 1



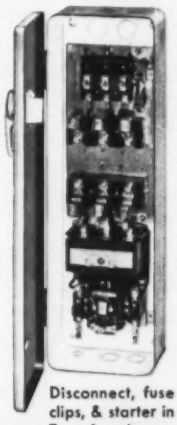
Disconnect, transformer, & starter in Type 12 cabinet.

SIZE 2



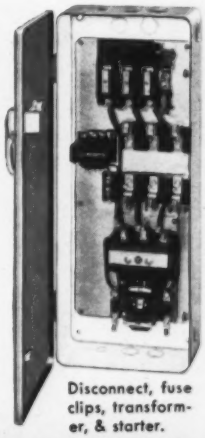
Disconnect & starter in Type 1 steel enclosure.

SIZE 2



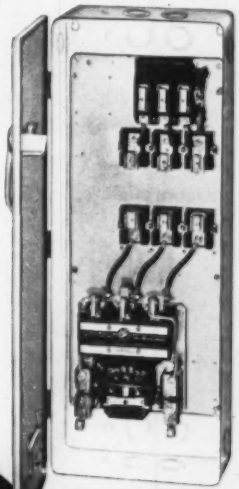
Disconnect, fuse clips, & starter in Type 1 enclosure.

SIZE 3



Disconnect, fuse clips, transformer, & starter.

SIZE 4



Disconnect, fuse clips, & starter in Type 1 enclosure.

Allen-Bradley Co.
1316 S. Second St.
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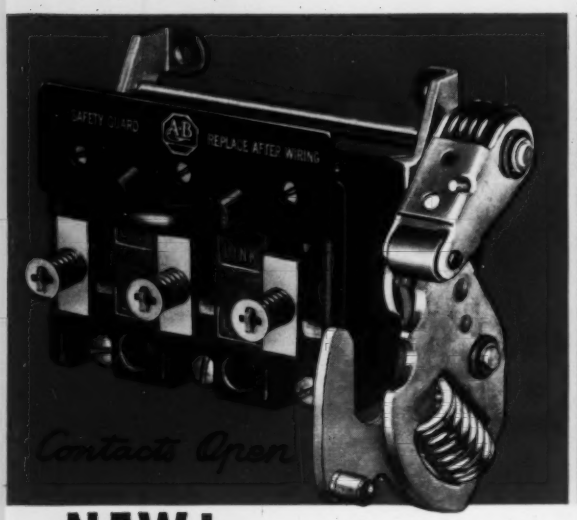
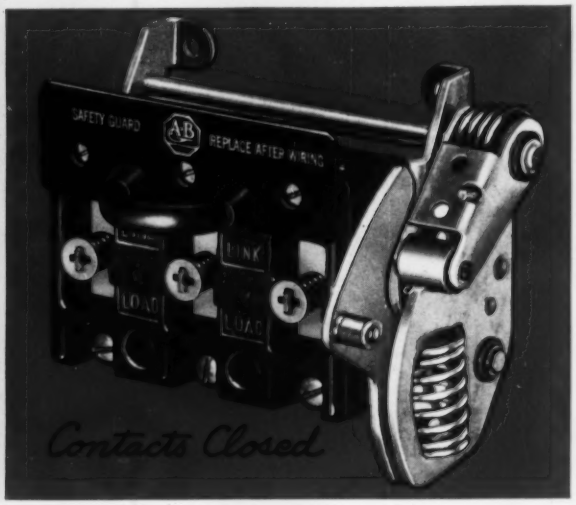
ALLEN-BRADLEY

TROUBLE FREE MOTOR CONTROLS

A-B Quality

4-56-MR



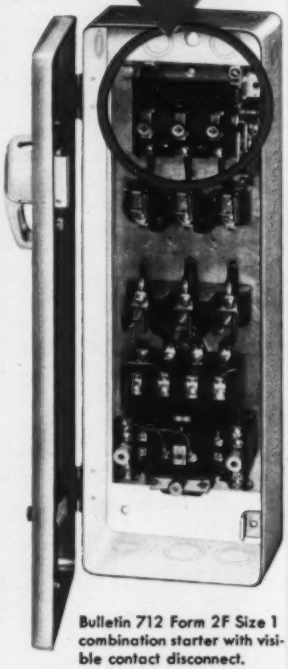


NEW! The first disconnect switch with movable contacts that are plainly visible in the OFF position

Allen-Bradley has finally succeeded in producing a disconnect switch, which removes all doubt whether the movable contacts are in the "open" or "closed" position. When in the "open" position, they are plainly visible—as open; when in the "closed" position, they are dropped—out of sight in the arc hood.

The moving, double break contacts of the new disconnect (shown in yellow above) move horizontally in individual arc chambers. When the disconnect is CLOSED, the moving contacts are DOWN in the arc chambers. In the OPEN position the moving contacts are UP in plain view, as shown in the colored illustration directly above.

If a contact should stick or weld, it will fail to rise to its "open" position and thereby indicate that the respective "link" remains closed—a plainly visible warning signal to the maintenance man.



Bulletin 712 Form 2F Size 1 combination starter with visible contact disconnect.

A unique feature of the new line are the interlocks built into the disconnect lever.

First—the disconnect lever is interlocked with the door latch so that the door cannot be opened unless the lever is in the OFF position. This assures that the starter is "dead" when the cabinet is open and is safe to inspect.

Second—the disconnect lever has a concealed release pin used only by authorized persons for opening the cabinet door, if needed, without shutting down the motor.

Standard operating lever permits use of one to three padlocks to lock in "off" position, but also can very simply be changed to permit padlocking in "on" position.

These new Bulletin 712 combination starters are available in NEMA Type 1, 4, 7, 9, and 12 enclosures. They are listed from 1 to 100 hp, 220 v; 200 hp, 440-550 v.

Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis. • In Canada—Allen-Bradley Canada Ltd., Galt, Ont.

A-B

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TROUBLE-FREE MOTOR CONTROLS

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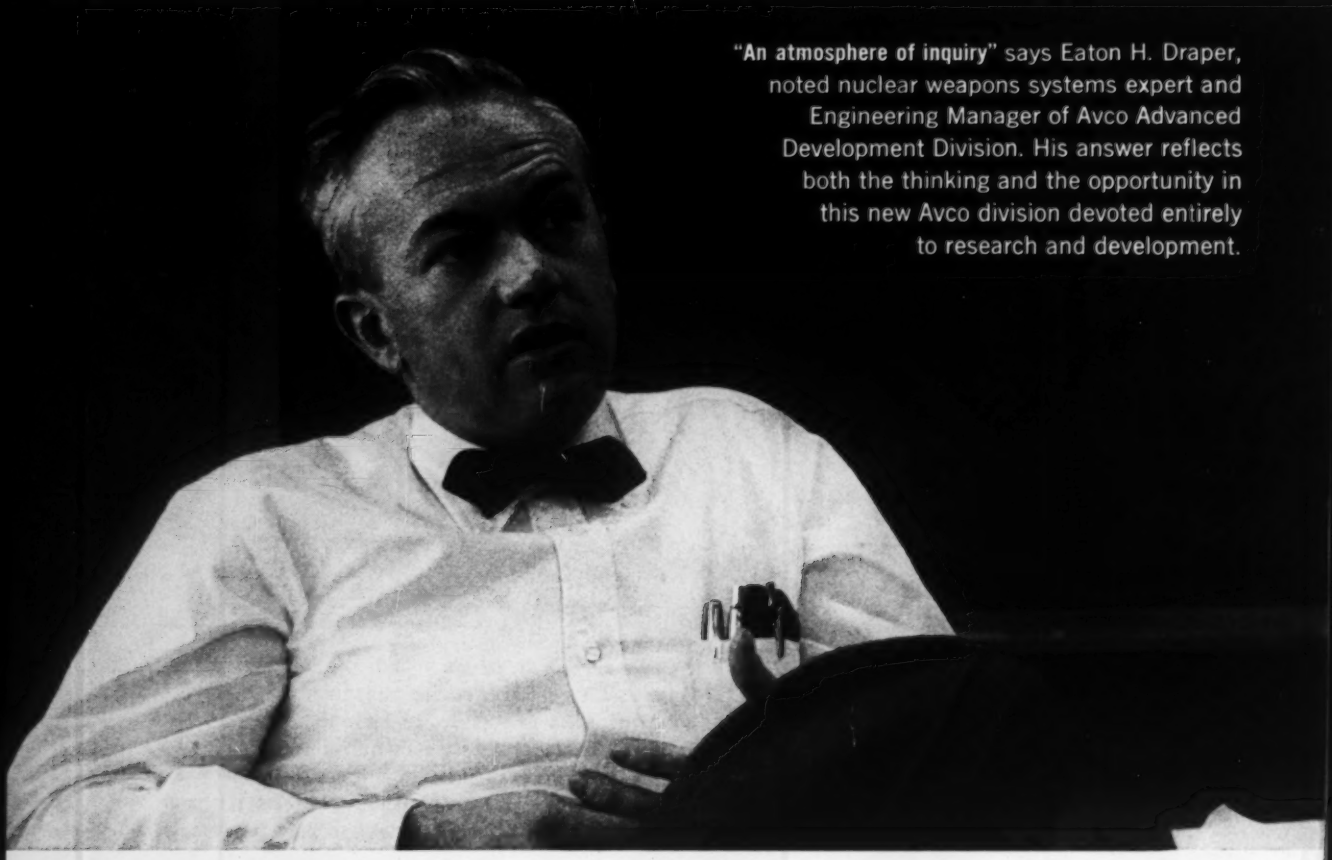

"An atmosphere of inquiry" says Eaton H. Draper, noted nuclear weapons systems expert and Engineering Manager of Avco Advanced Development Division. His answer reflects both the thinking and the opportunity in this new Avco division devoted entirely to research and development.

"Top-level associates, freedom from routine, and technically sophisticated assignments are all vital. But the one most important factor is a climate which encourages a healthy questioning of the known, as well as the unknown. Given this, a scientist or engineer will perform at his peak, and beyond."

Helping talented engineers and scientists perform at their peak is the best way we know of helping our own growth. For outstanding men at all levels, Avco's long-range expansion—in missiles and in all the physical sciences—offers unprecedented opportunity. Write: Dr. E. R. Piore, Vice-President in Charge of Research, Room 412, Avco Advanced Development Division, Stratford, Conn., or Phone Bridgeport, Conn., DRexel 8-0431.

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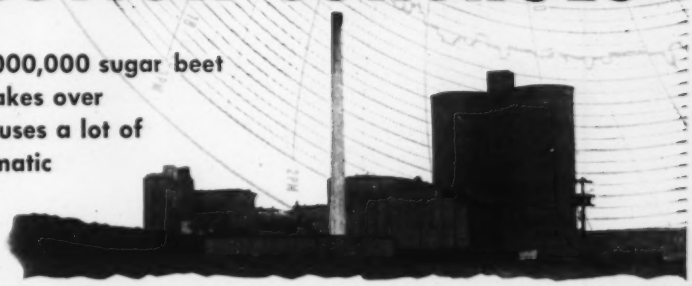
combine the scientific skills, and production facilities of 3 great divisions of Avco Manufacturing Corp.: Avco Advanced Development; Crosley; Lycoming—which currently produce power plants, electronics, airframe components, and precision parts.

Process CO_2 and Steam Needs Met on Low Grade Western Coal

with REPUBLIC *Automatic* COMBUSTION CONTROLS

Utah-Idaho Sugar Company's new $7,000,000 sugar beet factory at Moses Lake, Washington, makes over 75,000,000 lbs. sugar each year, and uses a lot of steam and CO_2 to do it. Republic automatic combustion controls meet these multiple needs efficiently.

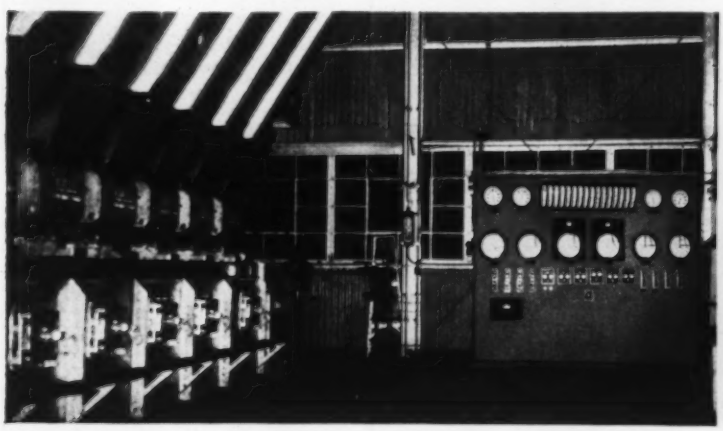


High CO_2 in the flue gas is an important indication of combustion efficiency, but it has added importance at the new Moses Lake plant of the Utah - Idaho Sugar Co. High CO_2 production must be maintained to assure adequate supplies of the gas for processes, and the concentration of CO_2 in the flue gas is important to the cost of its extraction.

Republic Automatic Combustion Controls keep the CO_2 at a high 12-13%, despite the low-grade western coal being burned.

The plant's spreader-stoker-fired 250,000 lb/hr boiler must be regulated to meet the CO_2 quantity and concentration requirements while furnishing the needed process steam at top efficiency. Plant operators report that the Republic controls meet these multiple requirements even during ash removal, soot blowing, and fire cleaning—without disturbing the fuel-air ratio and *while on fully-automatic control.*

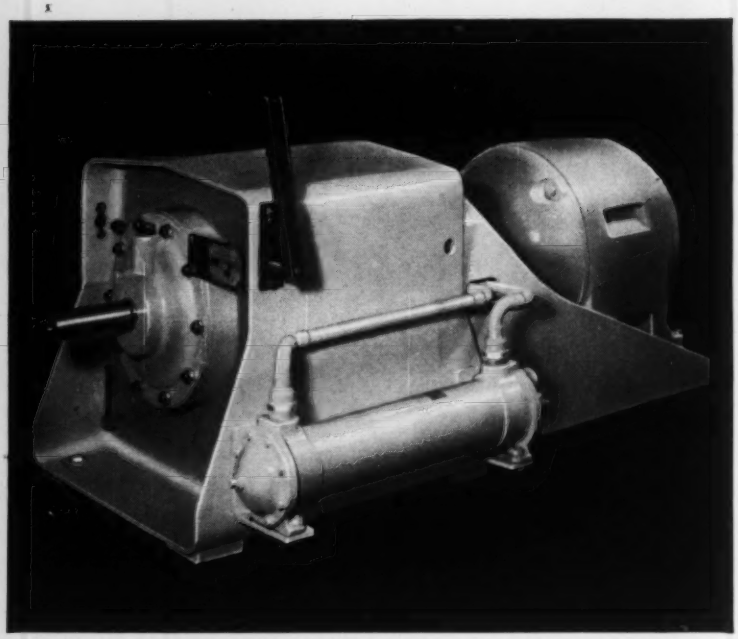
Speed-controlled forced and induced draft fans regulated by the combustion controls maintain proper draft without dampers, and despite a high stack. A three-element Republic boiler feedwater system is also regulated by the combustion controls to meet water requirements at all steaming rates.



This plant is another example of how Republic combustion engineers can work to unusual and rigid specifications in designing and building combustion controls for individual requirements. To get top boiler performance and those extras that your plant needs, ask Republic to design and build your combustion control system.

REPUBLIC
FLOW METERS CO.
2240 Diversey Parkway
Chicago 47, Illinois

Gýrol Fluid Drives limit torque to give you a built-in safety factor!



Type VS, Class 2 Gýrol Fluid Drive is available in ten sizes, 1 hp to 800 hp, speeds to 3600 rpm.

The American Blower Type VS, Class 2 Gýrol Fluid Drive not only offers adjustable, stepless speed control, but its inherent shock - absorption ability protects machinery.

For, a Gýrol Fluid Drive will limit the amount of torque which can be transmitted under overload conditions. This torque-limiting capacity can be adjusted by merely positioning the speed-control lever.

What's more, Fluid Drive permits the motor to come up to speed under almost no-load conditions—allowing simplification of motors and starting equipment for heavy starting loads.

You'll discover many more important benefits for a wide variety of industrial applications by calling our nearest branch.

FEATURES

- Can be reversed while in motion by reversing motor
- Across-the-line starting on many applications
- Motor can reach full speed before engaging load
- A compact, self-contained unit
- Trigger-action response — adjustable speed
- Speed may be controlled manually or automatically

Speed control for the paper and textile industries

Papermaking and processing machinery needs smooth starting to prevent tearing; adjustable speed to adjust machinery to humidity, paper thickness; no-load starting to keep power requirements down. Fluid Drive is the practical answer. It meets these problems easily — and without excessive maintenance. In the same manner, textile machinery needs accurate speed control to give maximum production rates within safe limits for the yarn. Again the answer is Gýrol Fluid Drive. Consult our nearest branch office or write us for information.

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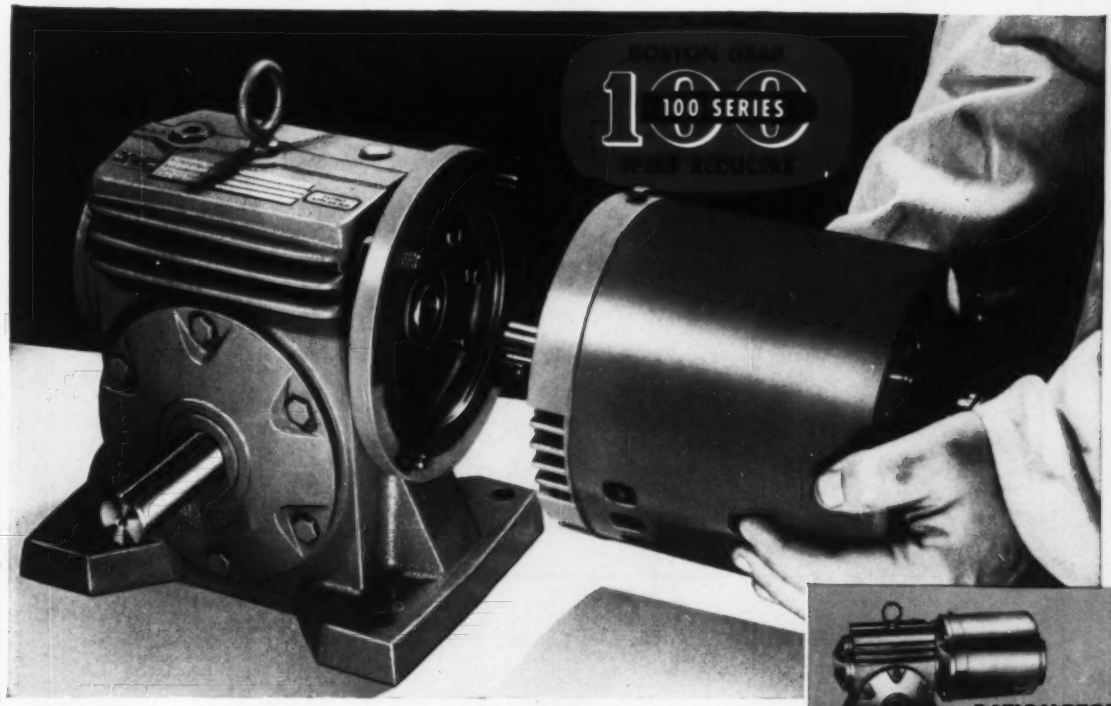

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New COST-SAVING "COMBINATION"

permits motor change in minutes . . . continued operation with spare

The new 100 SERIES RATIOMOTOR combines a gear reduction unit and an easily detachable, standard end-mounted motor.

MOTOR CAN BE REMOVED and replaced in a few minutes, without disturbing the gear reduction unit. Saves maintenance time, preserves alignment, permits continued operation with spare motor.

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The complete power package, with motor.

SOLD WITH OR WITHOUT MOTOR

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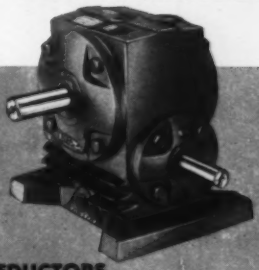
The Ratiomotor gear unit, supplied without motor. You buy and attach any motor you choose.



REDUCTORS
For mechanical drives, new 100 SERIES design saves space and weight. Housings are finned for improved cooling. Fan-cooling optional on larger sizes.

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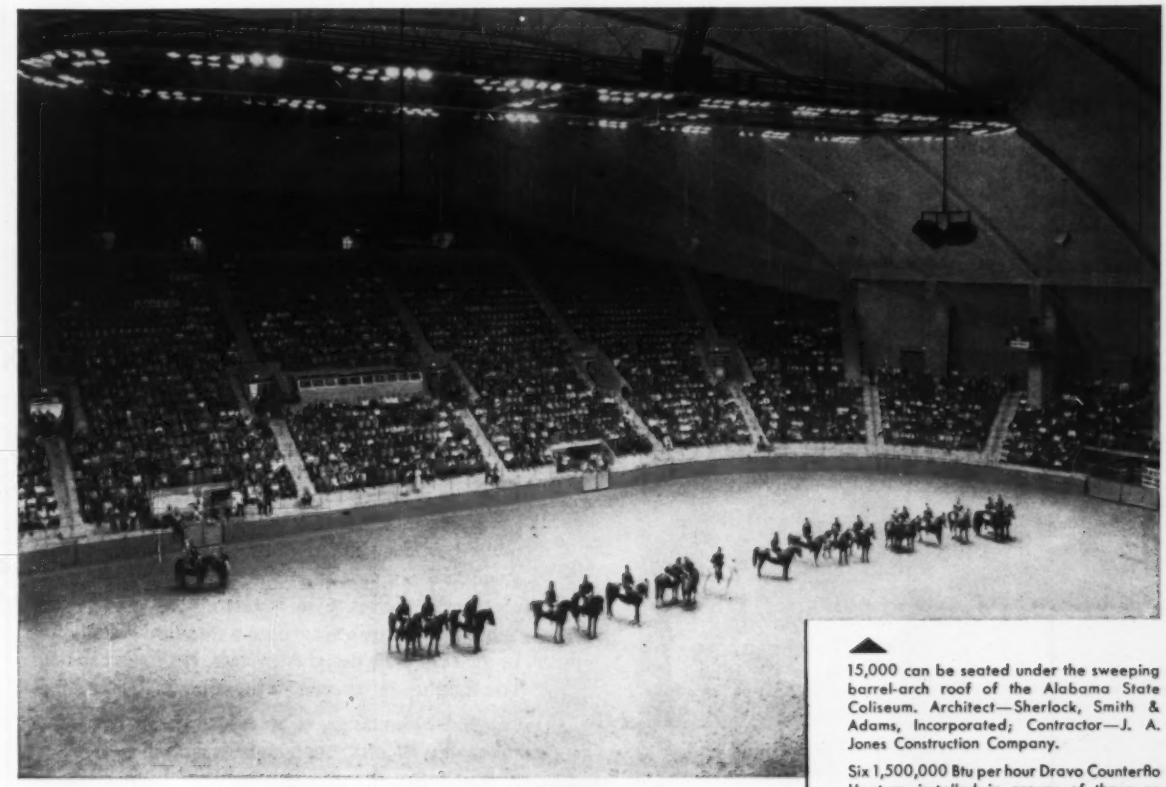


15,000 can be seated under the sweeping barrel-arch roof of the Alabama State Coliseum. Architect—Sherlock, Smith & Adams, Incorporated; Contractor—J. A. Jones Construction Company.

Six 1,500,000 Btu per hour Dravo Counterflo Heaters, installed in groups of three on opposite sides of the arena, operate automatically to provide heat as needed. A seventh Dravo Counterflo, rated at 500,000 Btu per hour, heats the basement.

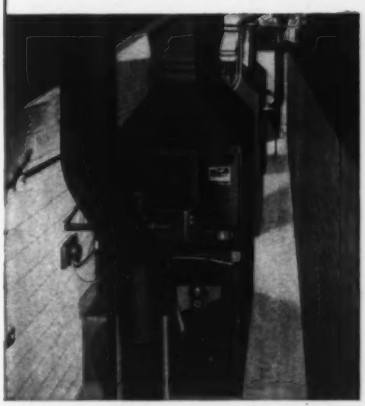
How Alabama solved unusual heating problems in its new Coliseum

Keeping the new Alabama State Coliseum at Montgomery comfortable posed many unusual problems for heating engineers. Size alone presented a big enough problem—the building is 10 stories high and almost the length of an average football stadium—but added were many special conditions.

When the building is empty heat loss amounts to 9,800,000 Btu per hr, but when filled, body heat sometimes raises temperatures enough that heat and humidity must be removed. The large open area also makes it difficult to provide uniform, easily controlled heat at all seating levels. Other rigid requirements include concealment of heaters to permit unobstructed visibility and quiet operation. With the aid of seven Dravo *Counterflo* Heaters the engineers solved all these problems.

Installed under the stands of the arena are six Dravo heaters that pull in fresh and return air in proportion to the Coliseum's needs. This air is quickly heated by the Dravo units and quietly distributed to all parts of the building. Functioning with the heaters is a sensitive temperature-humidity control system that operates the heaters or a series of exhaust fans, according to on-the-spot heat-ventilation requirements. The fully modulated *Counterflo* Heaters, with their stainless steel combustion chambers, are ideally suited for this precise job of providing instantaneous heat delivery when needed—or fresh tempered make-up air when ventilation is required.

Just as they've economically solved the unusual heating problems in this huge Coliseum, Dravo heaters can effectively meet your needs, large or small. For fast proof, use the coupon.



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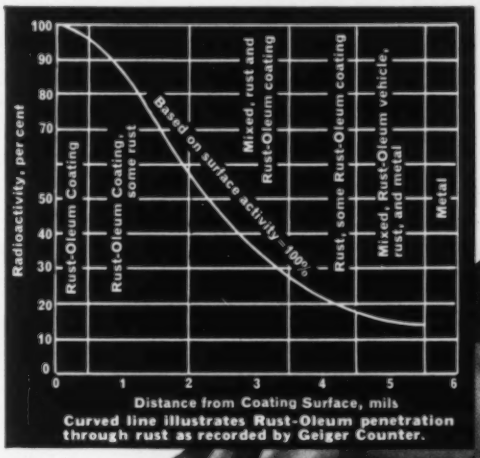
PENETRATION

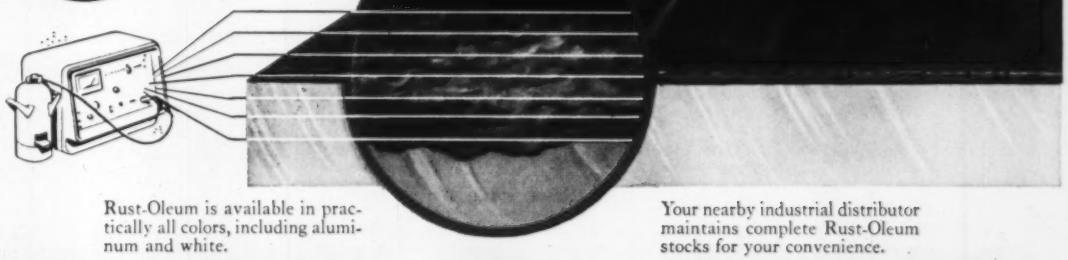
through rust to bare metal traced by Geiger Counter. To effectively stop rust—the vehicle of a protective coating, when applied over a sound, rusted surface—must penetrate through the rust down to bare metal. **Rust-Oleum does exactly that!—as proved by radioactive research!** Rust-Oleum's specially-processed fish oil vehicle was radio-activated and formulated into Rust-Oleum 769 Damp-Proof Red Primer—then applied to rusted test panels. Penetration *through rust* to bare metal by Rust-Oleum's specially-processed fish oil vehicle was then traced by Geiger Counter.

You stop rust, because Rust-Oleum's fish oil vehicle soaks deep down to bare metal and into the tiny pits where it drives out air and moisture that cause rust. You save, because this same *penetration* enables you to apply Rust-Oleum directly over rusted surfaces—usually eliminating costly surface preparations. Attach coupon to your letterhead for your thirty-page report entitled, "The Development of a Method To Determine The Degree of Penetration of a Rust-Oleum Fish-Oil-Based Coating Into Rust On Steel Specimens," prepared by Battelle Memorial Institute technologists.



Curved line illustrates Rust-Oleum penetration through rust as recorded by Geiger Counter.

There is only one Rust-Oleum. It is distinctive as your own fingerprint. Accept no substitute. Buy—and specify only Rust-Oleum. You'll be happy that you did.



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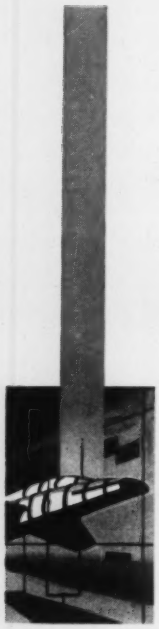

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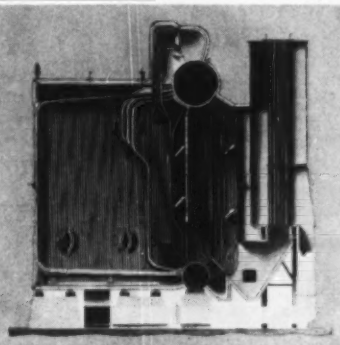

C-E Vertical Unit Boiler, Type VU-55

The VU-55 Boiler is available in six sizes ranging from 50,000 to 120,000 lb of steam per hr. It is designed for two pressure ranges—up to 250 psig and to 500 psig. These units are arranged for the application of superheater surface and heat recovery equipment if desired. VU-55 Boilers are designed for the pressure firing of oil or gaseous fuel and require no induced draft fan. They are equipped with tangential burners and tangent tube furnace walls to assure a level of performance which compares favorably with modern utility practice. The VU-55 Boiler is bottom supported requiring no supporting steel structure. The absence of exterior ductwork permits a smooth, streamlined exterior which is both attractive and practical.

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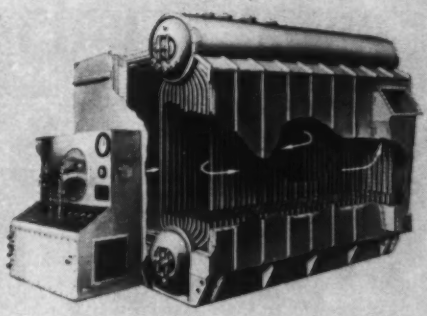
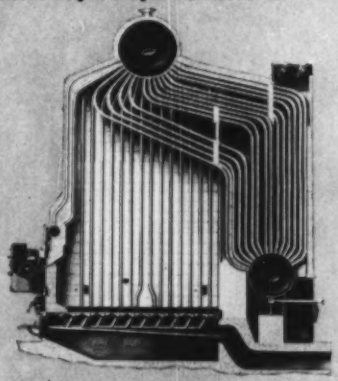
This completely shop-assembled boiler is available in fourteen sizes from 4,000 to 40,000 pounds of steam per hour . . . for operating pressures up to 500 psi . . . for pressure firing of liquid or gaseous fuels. The VP Boiler has more water-cooled area per cubic foot of furnace volume than any other boiler of its size and type. The large lower drum—30-inch diameter—permits a simple, symmetrical tube arrangement . . . greater water storage capacity . . . easy access for washing down or inspection. A centrifugal fan, which operates at low speed and is exceptionally quiet in operation, is standard equipment. The simple baffle arrangement results in low draft loss . . . simple soot blowing . . . no dead pockets . . . high heat absorption. The VP is enclosed in a reinforced gas-tight, welded steel casing, and shipped completely assembled with firing equipment, fittings and forced draft fan. For foundation, it needs only a simple concrete slab.





C-E Vertical Unit Boiler, Type VU-10

The VU-10 is available in nine sizes from 10,000 to 60,000 pounds of steam per hour . . . for operating pressures up to 475 psi . . . superheat to 200° F in 20,000-60,000 lb range . . . for solid, liquid, or gaseous fuels. This boiler is a completely standardized design adaptable to many conditions. It is bottom-supported and needs no outside supporting steel. It operates efficiently over a wide range of output, and is easy to operate and to maintain. All parts are easily accessible for inspection. The VU-10 is a complete unit—boiler, furnace, setting, fuel-burning equipment, controls, forced draft, heat recovery equipment (if desired). Regardless of fuel, the same general cross-sectional arrangement of drums, convection bank and furnace wall cooling is used. Uniform design through each transverse section assures even water level in the drum and uniform expansion.

A C-E Industrial Boiler for Every Need—Combustion Boilers are available in many other 2-drum designs—for capacities up to 350,000 pounds of steam per hour—and to burn any commercially available fuel. All of these boilers can be designed for use with pressures up to 1375 psi and steam temperatures as high as 960 F—utilize any type of heat recovery equipment—fit difficult space conditions. Let us give you full details on the complete line of C-E Industrial Boilers, including the C-E LaMont Controlled Circulation Hot Water Boilers. B-852A

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The boom in production means more pressure than ever for engineering prints. A new, modern reproduction unit with higher speeds, more operator conveniences will help you deliver them.

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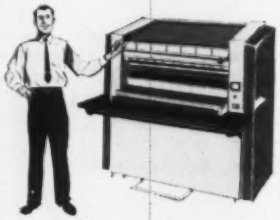

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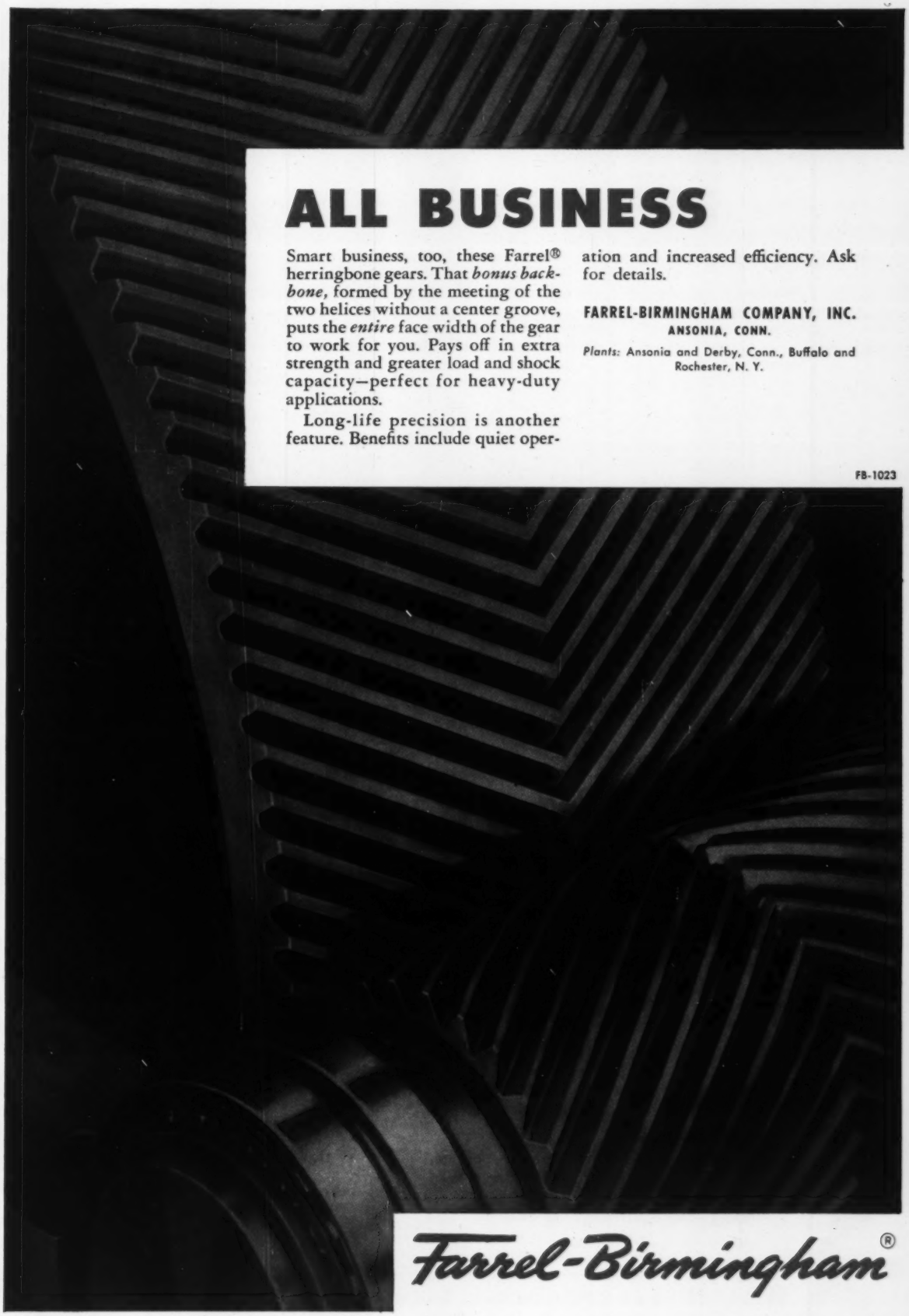

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Smart business, too, these Farrel® herringbone gears. That *bonus backbone,* formed by the meeting of the two helices without a center groove, puts the *entire* face width of the gear to work for you. Pays off in extra strength and greater load and shock capacity—perfect for heavy-duty applications.

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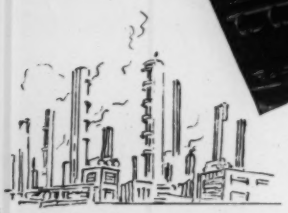
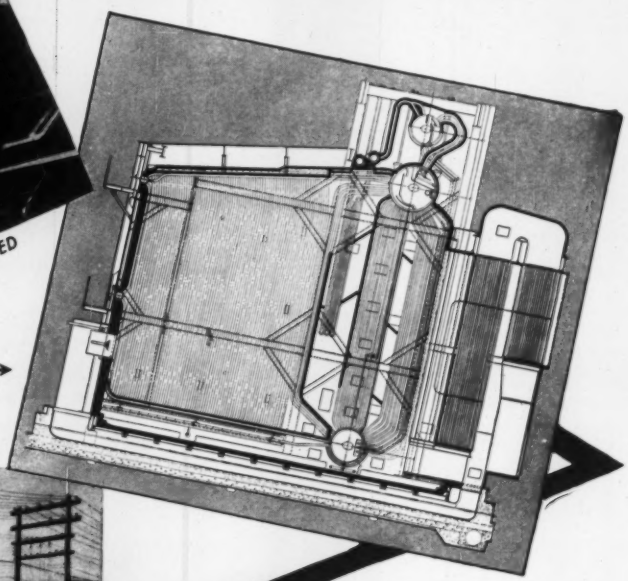
STEAM GENERATOR

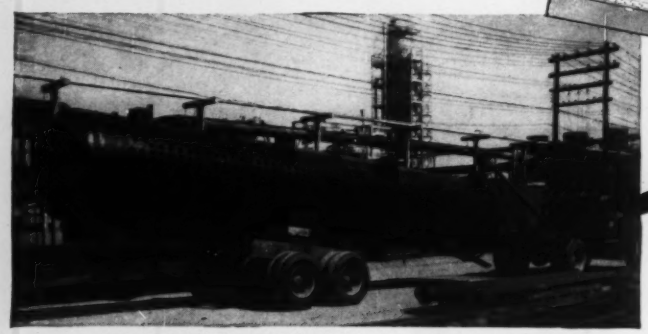
Gives Top Performance in a Leading Texas Petroleum Refinery

VIEW OF THE COMPLETED STEAM GENERATOR



RIGHT → LONGITUDINAL SECTION THROUGH THE UNIT.





6'-6" DIAMETER x 37'-0" LONG STEAM DRUM BEING TRANSPORTED TO THE ERECTION SITE DURING INSTALLATION.

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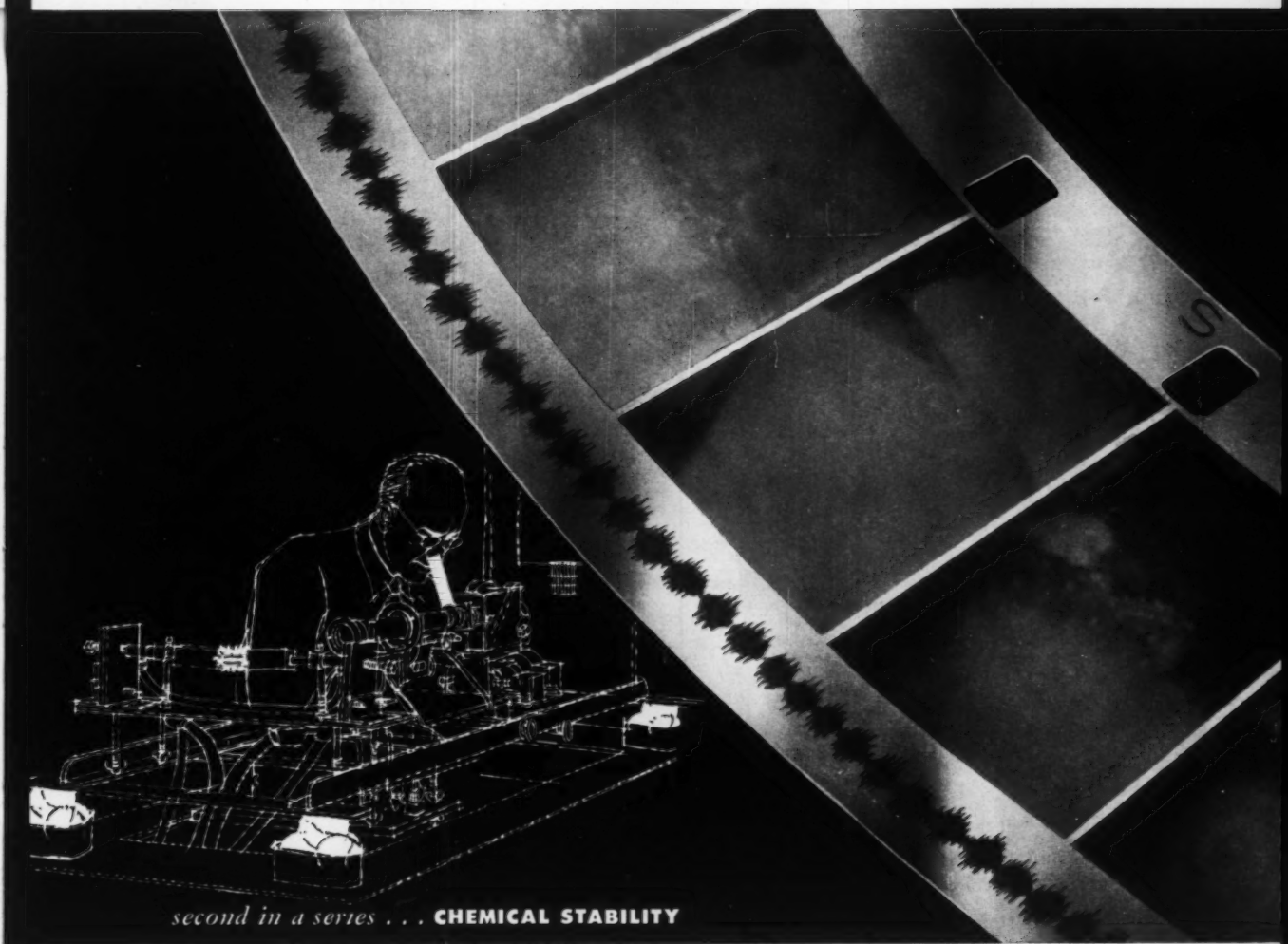

Comparative stability of MONOFRAX® fused cast refractory (left) vs. fireclay (right) . . . under attack by molten glass, as viewed through the high temperature microscope — one of Carborundum's most useful test facilities. (16 mm. frames shown are not consecutive.)

Unusual Properties of Refractory Materials

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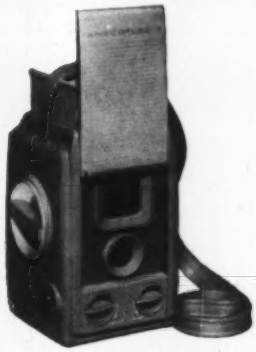
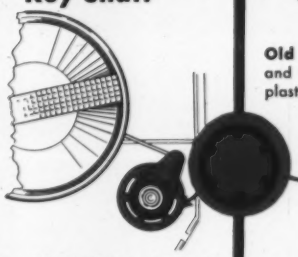
5 Waldes Truarc Rings simplify assembly, eliminate parts, bring big over-all savings to new design low-cost camera

Anscoflex II Camera



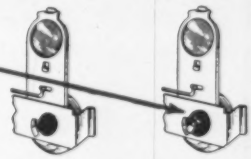
Key Shaft



Parts originally designed for self-locking Truarc ring (series 5105). Some cameras in the past had brass cup staked to the body. At times staking operation cracked the plastic, resulting in loss of expensive part.

Portrait and Filter Lens Knob Assemblies

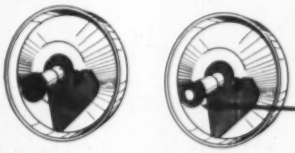
Old way: Knob with plastic shaft used washer and heat forming operation that flattened the plastic pin and locked the pivot in position.



Truarc way: Molded plastic knob with pin is easily and quickly held by a Truarc self-locking ring (series 5105). No groove is necessary. Washer is eliminated and it is possible to remove ring if necessary without damage to knob.

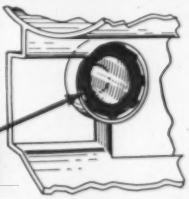
Winding Knob

Old way: With screw and washer design, it was necessary to disassemble entire camera to remove screw which secured winding knob. Self-topping screw sometimes failed to secure knob, produced excessive end play.



Truarc way: Truarc "E" ring (series 5133) allows removal of winding knob without major disassembly of camera, reducing repair time. Use of stacked rings and Truarc applicator saved $10.40 per M on labor. Material saving: $2.29 per M.

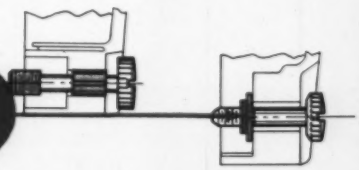
Rear Lens



Parts originally designed for self-locking Truarc ring (series 5005) Some cameras in the past had glass element secured by heat forming tabs from plastic body. Loose or chipped elements resulted in loss of both parts.

Flash-Gun Case Assembly

Old way: In the original design a sleeve was wrapped around neck of screw and pressed into hole of plastic cover. Close working areas made assembly difficult and required extra operation to lock ring into place.



Truarc way: Series 5133 E-Ring snaps onto unthreaded shank of screw quickly, needs no special groove. Labor saving $7.06/M.

Ansco, Binghamton, N. Y., uses the latest technical advances in construction to produce an economical, easy-to-use reflex camera. 5 Waldes Truarc Rings are used in this new design to save material and labor costs, eliminate parts, simplify assembly and reduce rejects.

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ME 048

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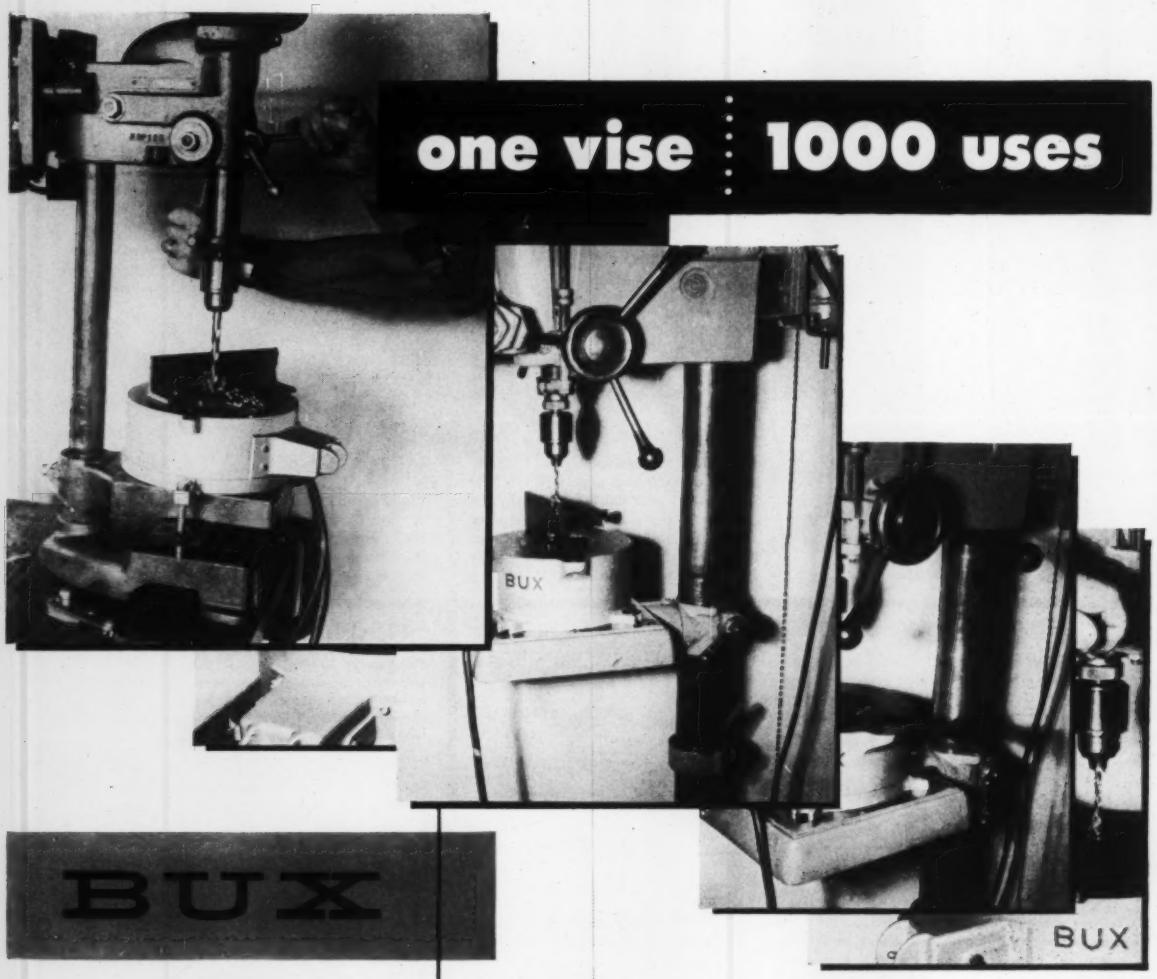

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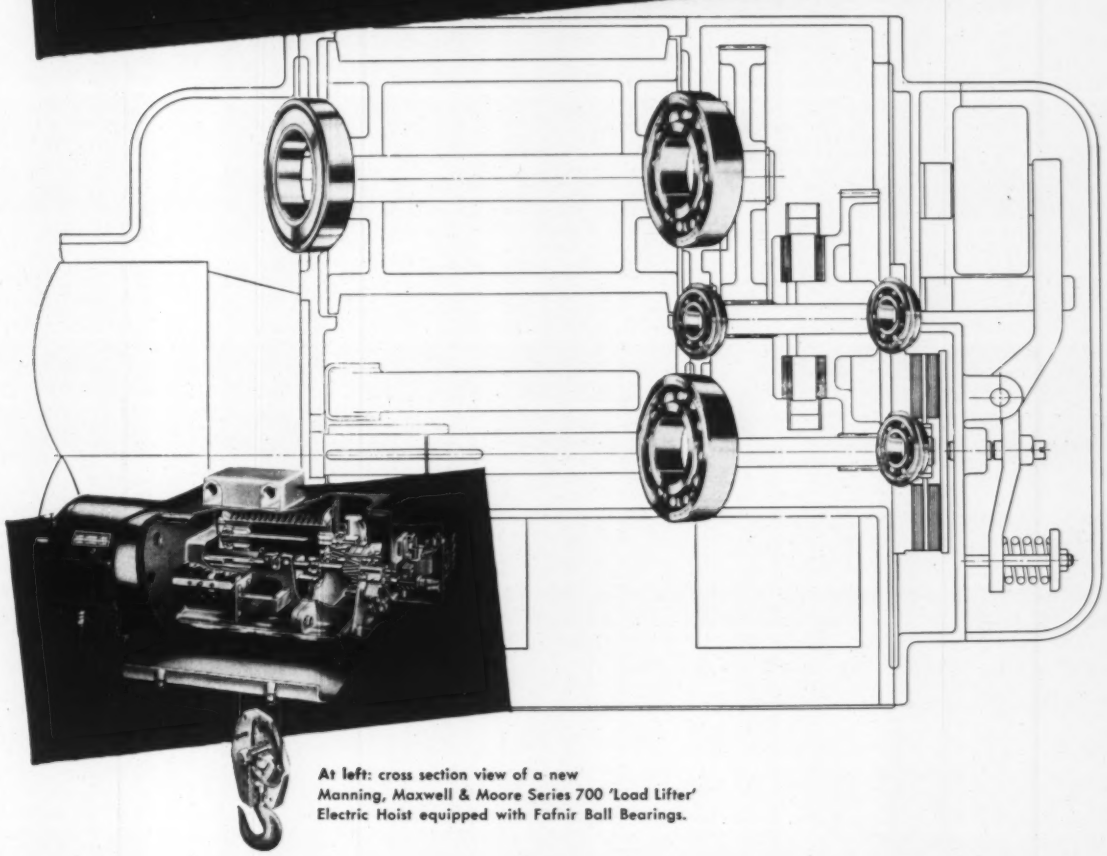
How an "Industrial Muscle" is kept from getting "Muscle-bound"



At left: cross section view of a new Manning, Maxwell & Moore Series 700 'Load Lifter' Electric Hoist equipped with Fafnir Ball Bearings.

Every bearing indicated in the diagram above highlights the strategy of Manning, Maxwell & Moore's electric hoist designers. Each eliminates a possible source of trouble caused by friction... on rope drum (bearing lubricated for life) on trolley assembly, on gear shafts, etc.

With critical turning points protected, this heavy-duty 1-ton capacity hoist is offered for three-shift lifting *every day in the year*. It lifts a ton, thirty feet a minute. Power is concentrated on lifting, not shared to overcome friction. It's smooth, steady, and efficient. Lubrication becomes a minor detail.

Fafnir is a supplier of Ball Bearings for Manning, Maxwell & Moore hoists and for hundreds of other industrial machines where Ball Bearing advantages improve performance and prolong service-life. The choice of Fafnir Ball Bearings, in case after case, has been influenced by the Fafnir "attitude and aptitude" . . . a way of looking at bearing problems from the designer's viewpoint, an aptitude for supplying the right ball bearing to fit the need. Maybe these attributes can help you solve a bearing problem. The Fafnir Bearing Company, New Britain, Connecticut.

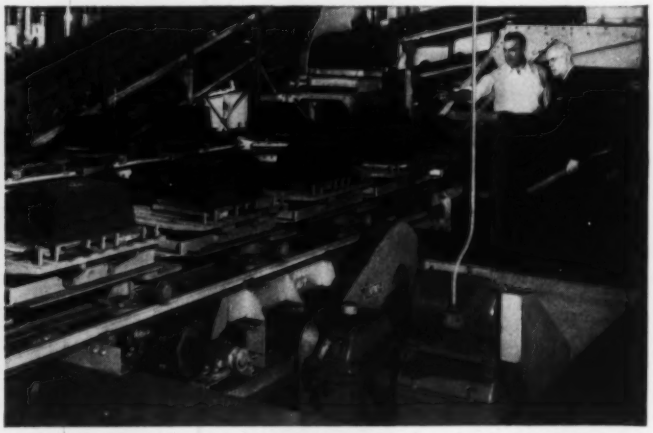
FAFNIR **BALL BEARINGS**

MOST COMPLETE LINE IN AMERICA

Brick sales booster: Giving the customer the color he wants helps sell bricks as well as autos. The Stone Creek Brick Co., Stone Creek, Ohio, gets the *exact* color in every batch by proportioning brick ingredients with Jeffrey Waytrols. You'll find these electric vibrating feeders in hundreds of processing plants . *automatically* weighing and delivering *exact* quantities of material for top quality products. Bulletin 841 gives data on Waytrols.

How's your drive? If you're driving a mixing drum or other equipment at an inclined angle, you can cut the wear with this new Jeffrey "offset" chain. Jeffrey chains and sprockets are available for thousands of power transmission and conveying jobs.

Solves sticky problem. Ordinary belt conveyor pulleys often collect sticky or abrasive material on their solid faces. This wears out the belt and gets it out of alignment. Here's Jeffrey's answer: the slatted wing type pulley, described in Bulletin 898. It is self-cleaning. Belts last longer. Downtime is checked.



Thinking about automation? You should see some of the latest foundries! Materials are being moved and processed like clockwork . . . at the push of a button. Did you know Jeffrey is the leader in this field? Our service includes not only unit machines but completely engineered foundry systems, like that shown.

Mechanize it with Jeffrey machinery and save. Your materials-handling and power transmission equipment will give more efficient, economical operation if you specify time-tested, dependable Jeffrey products. Convenient stock parts carried by authorized distributors. The Jeffrey Manufacturing Co., Columbus 16, Ohio.

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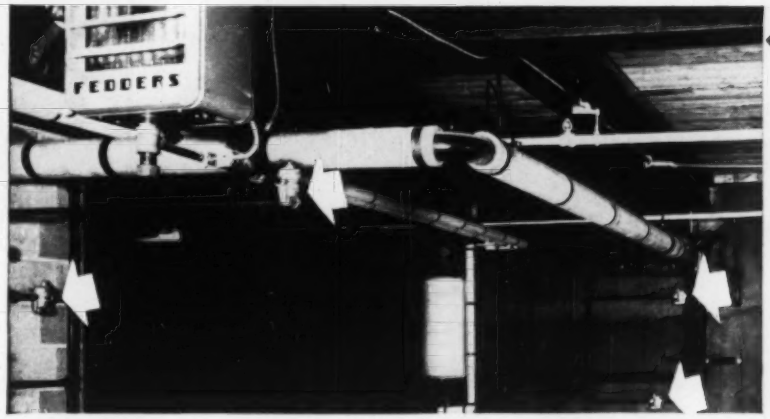
How One Company Has Saved $80,000 to Date by Buying 600 Steam Traps



Armstrong built-in strainer traps save maintenance as well as fuel at L. G. Balfour Co., Attleboro, Mass.

Joseph Brooks, Production Manager at Balfour, insists on "Armstrongs — *no substitute.*"

Armstrong Traps on Low Pressure, Vacuum Return Heating System Cut Fuel Costs $8,000 Per Year, Have Served 10 Years Without Repairs

YOU'D HAVE TO SELL a lot of fraternity pins to come out with $80,000 profit. But, that's the dollar-saving a couple of alert plant men have made by installing Armstrong steam traps at L. G. Balfour Company, fraternity jewelry makers of Attleboro, Mass. And, they've made their own jobs easier by doing it.

Just 10 years ago, Joseph Brooks, Production Manager, and C. J. Ripley, Maintenance Superintendent, installed the first Armstrong traps on their low pressure vacuum return heating system. Now they have 600 in use throughout the plant. The results have been an engineer's dream:

1. Fuel costs reduced $8,000 annually despite doubling of the factory's size and increased prices of coal.

2. One boiler did work of two after trap installation in original plant. Steam pressure was reduced from 50-75 lbs. to 22-27 lbs. Pressure is reduced to 4 lbs., with 6"-8" vacuum.

3. No trap repairs except cleaning in 10 years and no servicing of any kind where strainers were used ahead of traps. Armstrong Y-Type strainers have now been installed ahead of all No. 800 traps and all new traps are No. 880's with built-in strainer (costing less to buy and install than separate strainer and trap.)

This story of Balfour's $80,000 profit wouldn't be as significant if it were the only one of its kind. But, the frequency of such reports about Armstrong trapping establishes firmly the tremendous cost-reduction opportunities available to many plants throughout the country — perhaps to yours. Isn't it worth looking into?

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Boeing production engineering—precision on a big scale

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Mechanical engineers have great responsibilities in Boeing production: in tool design, industrial engineering, liaison, test equipment, and other fields.

These mechanical engineers devise new fabrication methods for materials like titanium, hard aluminum alloys, and bonded honeycombs. They have supervisory responsibility in developing, checking and controlling production processes. Because of steady expansion, more top-notch mechanical engineers are needed for the B-52 and the 707 jet tanker-transport—and for big programs now under way on the airplanes and guided missiles of a few years hence.

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American Felt Company

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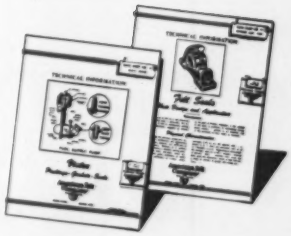

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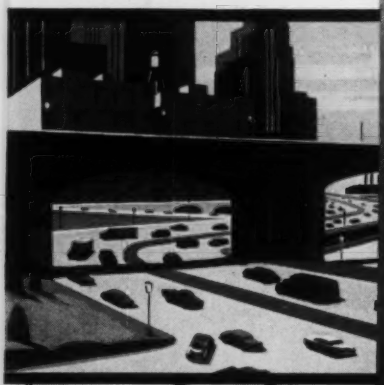

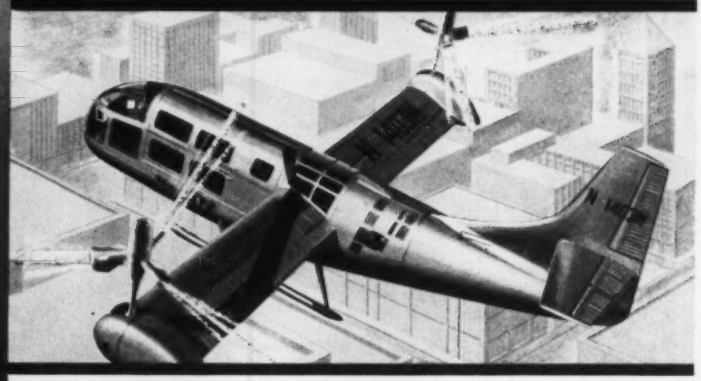

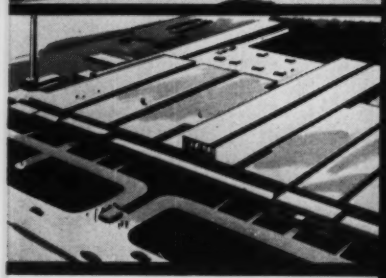

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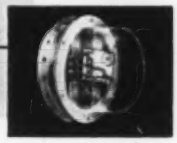

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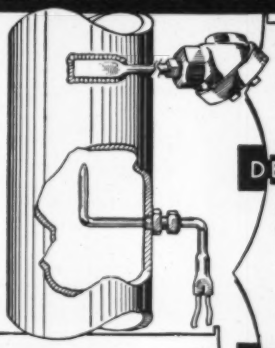

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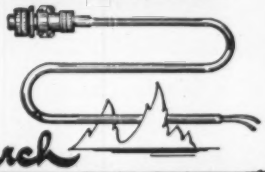

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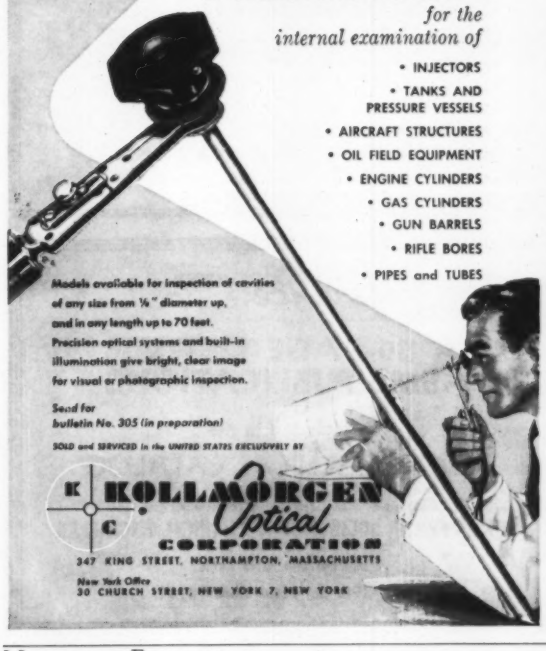

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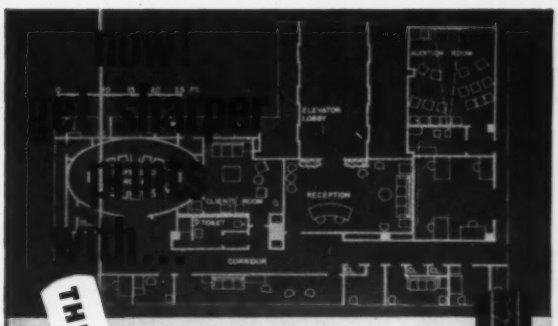

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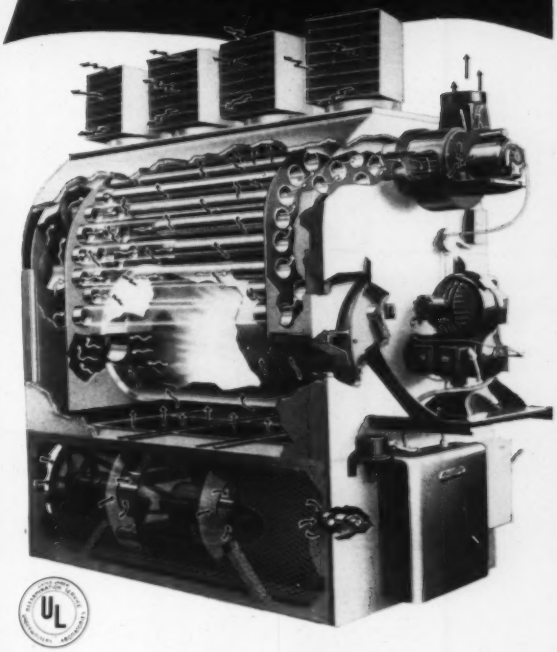

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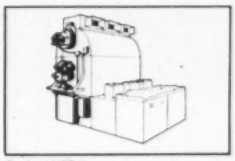

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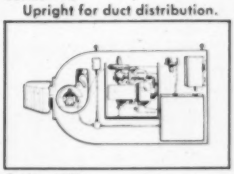

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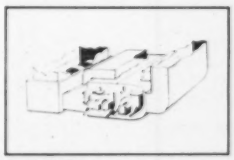

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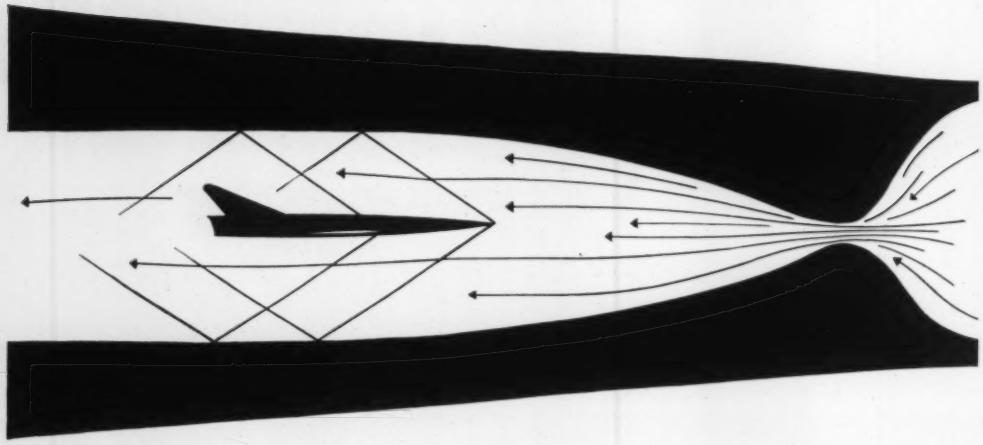

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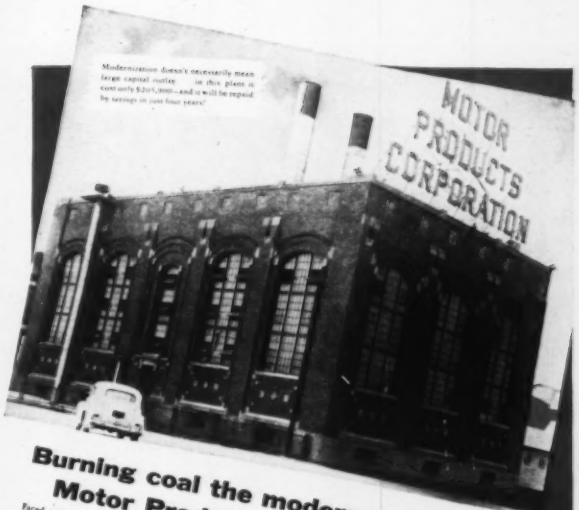
Write for Bulletin — No Obligation.



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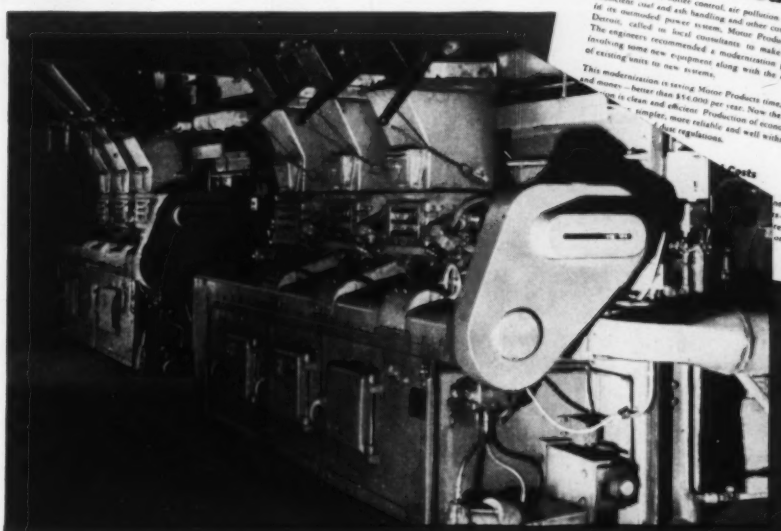

Power MODERNIZATION PROGRAM

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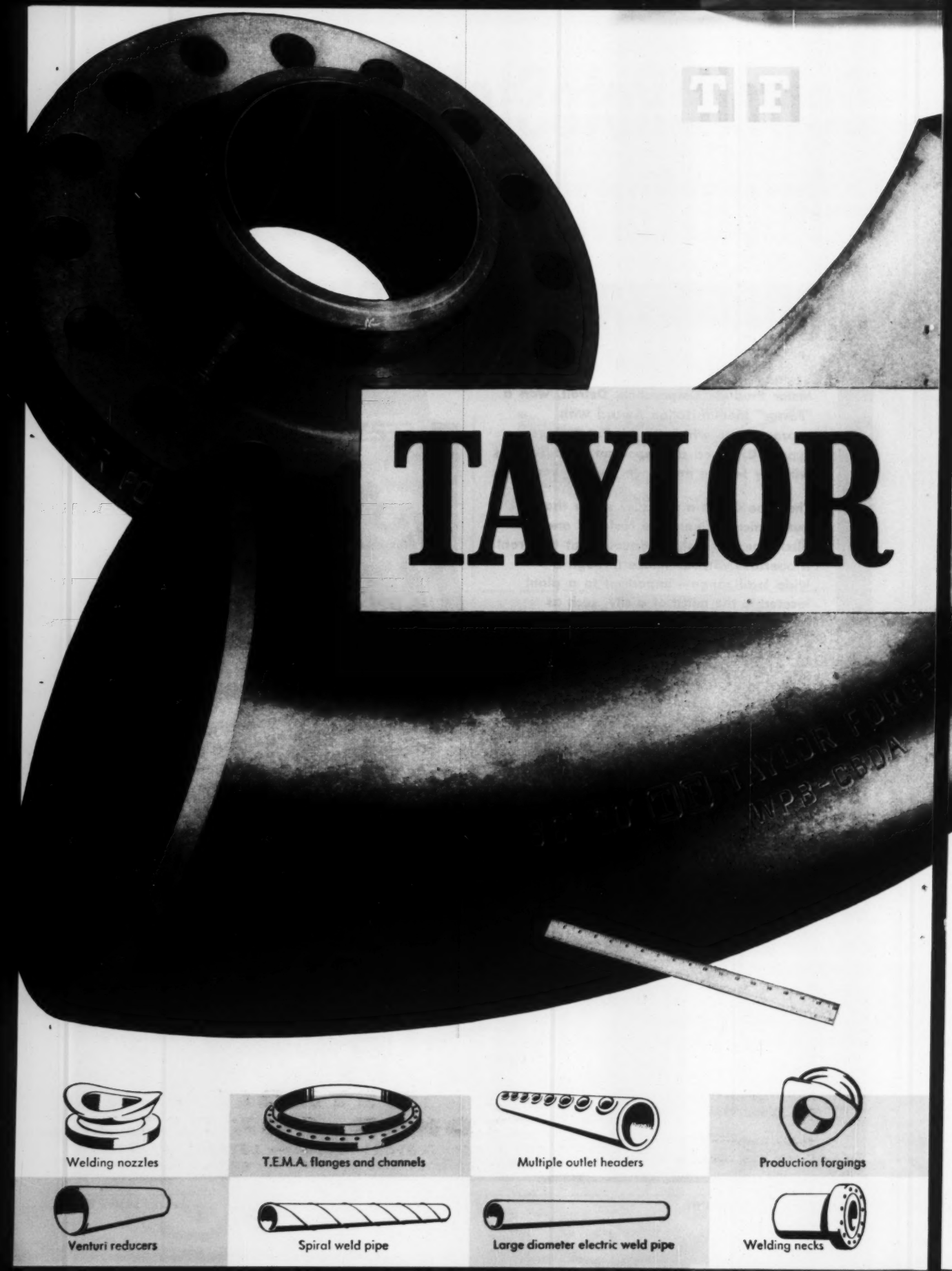

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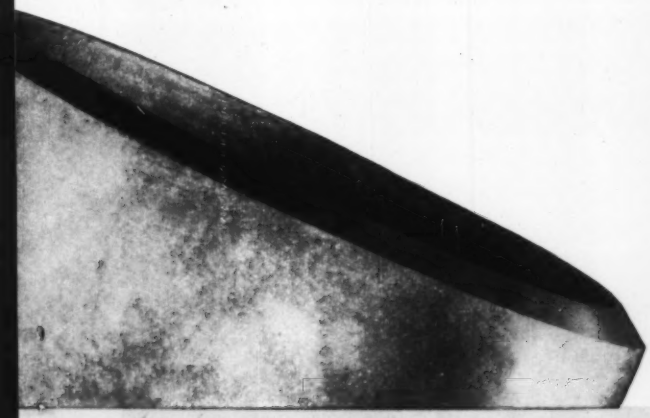

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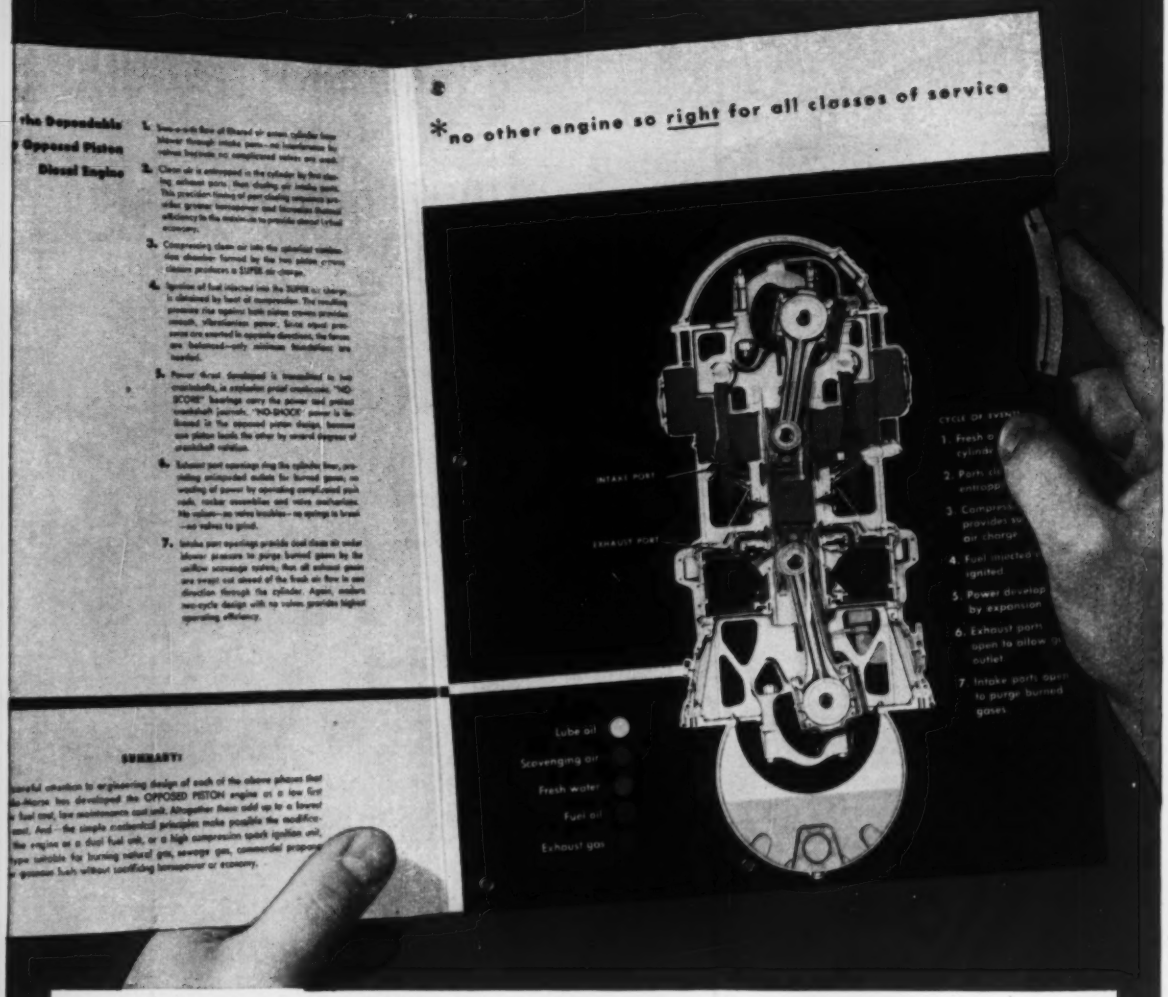
District Sales Offices: New York, Philadelphia, Pittsburgh, Atlanta, Chicago, Houston, Tulsa, Los Angeles, San Francisco, Toronto, Calgary.

CALL YOUR NEARBY TAYLOR FORGE DISTRIBUTOR

He carries a full stock of Taylor Forge Welding Fittings and Forged Flanges and can supply your needs promptly. He's a good man to know for he understands piping and through him you have available the services of Taylor Forge engineers for help and advice on any piping problems.

"Working Model" of the Opposed-Piston Diesel

YOURS FREE



Here in Graphic Full Color

is a detailed working model of the Fairbanks-Morse Opposed-Piston Diesel Engine—and it's yours free for the asking.

With the 8-inch operating cutaway in front of you, you can follow the complete operating cycle of this outstandingly successful heavy-duty engine designed for continuous service. Moving the disc at the right operates the model showing exact position of pistons, and color codes condition in the cylinder, throughout the entire cycle of events.

You'll also see the simplicity of the O-P that has no valves, intricate valve trains, cylinder heads and gaskets—in fact, it has 40% fewer moving—wearing—parts than any comparable engine of equal horsepower.

If you are interested in dependable power with low operating and maintenance cost, send for your working model of the O-P diesel today! Simply attach this advertisement to your letterhead (or ask for O-P "Working Model") and send to Fairbanks, Morse & Co., 600 S. Michigan Ave., Chicago 5, Illinois.

FAIRBANKS-MORSE
a name worth remembering when you want the BEST

DIESEL AND DUAL FUEL ENGINES · DIESEL LOCOMOTIVES
RAIL CARS · ELECTRICAL MACHINERY · PUMPS · SCALES
HOME WATER SERVICE EQUIPMENT · MOWERS · MAGNETOS

See 8-Foot Working Model in F-M Booth 42 at A.S.M.E. exhibit in New Orleans, April 2-5

Opportunities

positions open • positions wanted • equipment, material, patents, books, instruments, etc. wanted and for sale • representatives • sales agencies • business for sale • partnership • capital • manufacturing facilities

ANSWERS to box number advertisements should be addressed to given box number, care of "Mechanical Engineering," 29 West 39th St., New York 18, N. Y.

RATES: Classified advertisements under this heading in MECHANICAL ENGINEERING are inserted at the rate of $1.70 a line. $1.35 a line to members of ASME. Seven words to the line average. A box number address counts as one line. Minimum insertion charge, 5 line basis. Display advertisements carried in single column units of multiples of one inch at flat rate of $28 per inch per insertion. Copy must reach us not later than the 10th of the month preceding date of publication

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NEW PRODUCT DEVELOPMENT

Ingenuity and initiative applied to NEW PRODUCT DEVELOPMENT with a growing far-sighted company means progress for the experienced Electrical or Mechanical Engineers who are selected for these choice positions. Experience required in:

Mechanical Design
Heat Transfer
Servo Mechanisms
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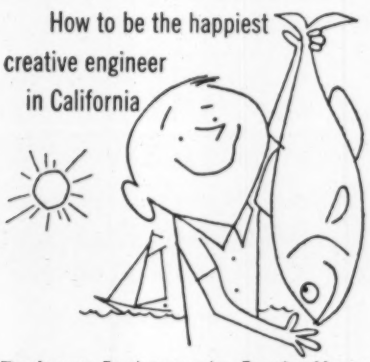
Electro-Mechanical Devices

These positions offer an opportunity to grow in the fields of ATOMIC POWER and AUTOMATION.

Reliance Electric & Engineering Co.
1088 Ivanhoe Road
Cleveland 10, Ohio
Glenville 1-3530 **Ext. 570**

How to be the happiest creative engineer in California



Beckman Instruments, Inc.* offers E.E.'s, M.E.'s, Manufacturing, and Sales Engineers the kinds of jobs that creative men dream about. Top salary, all employment "extras" including our Educational Assistance Plan, modern facilities and personal recognition that comes naturally with our decentralized operation. Small town living...but near metropolitan areas in either Fullerton, So. Pasadena, Newport Beach, Richmond or Palo Alto.

*We're pacing the commercial electronics field ($3,000,000 sales in 1949 to $21,000,000 sales in 1955) and we'll be disappointed if you don't grow with us.

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Write Beckman Instruments, Inc., 2999 W. 6th St., Los Angeles 5, Calif. Ask for Career File #14

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Engineering graduates for product design and application. Products are vibration and shock isolation systems on aircraft, electronic, automotive, marine, general industrial equipment. This is a rapidly expanding industry. Excellent long range possibilities for engineers who are interested primarily in design work. Duties also involve extensive liaison between and among field engineering, manufacturing, and research.

BOX 369, ERIE, PENNSYLVANIA

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or AE

ENGINEER

Design Turbine Type Engine Controls for Nuclear Propelled Aircraft

The next great step forward in aviation is nuclear propulsion. Now in the process of development at General Electric, this field offers great possibilities for individual achievement on both the professional and personal levels.

The present position requires 1 to 3 years' experience in aircraft control or accessory systems design and application, and involves the design of turbine type engine controls. Both creative and analytical ability are desirable.

Openings in Cincinnati, Ohio and Idaho Falls, Idaho.

Address replies to location you prefer

AIRCRAFT NUCLEAR PROPULSION DEPT.

GENERAL ELECTRIC

Att. Mr. W. J. Kelly
P. O. Box 132
Cincinnati, Ohio

Att. Mr. L. A. Munther
P. O. Box 535
Idaho Falls, Idaho

DEVELOPMENT ENGINEER

Recently-established Research & Development Laboratory offers opportunity to young Mechanical Engineer to develop experience in design and development of pneumatic control systems and components. M.S. degree desirable.

Robertshaw-Fulton Controls Co.
(Aeronautical Division)
Charles E. Balleisen, *Project Director*
Anaheim, California

MECHANICAL ENGINEER

Assistant plant engineer to train for two years to fill the position of plant engineer in a new organic chemical plant scheduled to begin operations in 1958. Five to seven years' experience in chemical plant maintenance and construction—organic chemical plant experience preferred. Send resume and salary requirements to

METAL & THERMIT CORPORATION
One Union Street, Carteret, New Jersey

PIPING DESIGN & LAYOUT ENGINEER
HEATING & VENTILATING ENGINEER

Due to our expansion program, the above-mentioned permanent positions are available in a large pulp and paper manufacturing plant in the Upper Midwest. The individuals desired should be graduate engineers with a minimum of five to ten years' experience who are well versed in their respective fields. Our employees know of these openings. Your confidential reply should include personal, educational and work history together with salary thinking.

Address CA-5540, % "Mechanical Engineering."

MECHANICAL ENGINEERS
A Career With . . . *Linde*

IN LIQUID NITROGEN

Unusual and challenging career openings are offered in liquid nitrogen APPLICATION DEVELOPMENT

- **indefinite preservation and processing of biological materials.**
- **design of liquid nitrogen vacuum insulated containers.**
- **application of extreme pressures and low temperature.**
- **application of liquid nitrogen temperature in the shipment of frozen foods without intransit refrigeration.**

The magnitude and diversity of LINDE products and processes are appealing to Mechanical Engineers who are seeking employment with a dynamic company of proven stability.

Bachelors or Masters are invited to investigate

LINDE AIR PRODUCTS COMPANY
a division of
UNION CARBIDE AND CARBON CORPORATION
Send resume to: Mr. P. I. Emch
P. O. Box 44, Tonawanda, New York
Refer to ad: ME-N

ESSO ENGINEERING

An organization now in the largest expansion program of its history. Has job opportunities in a wide variety of interesting work for young engineers with up to seven years' experience and with high college scholastic ratings.

Mechanical Engineers required for process design, refinery planning and layout, cost estimation, mechanical design, materials and equipment development for complete refineries and refinery units. Positions available in manufacturing work for project engineering, field engineering and equipment maintenance.

Chemical Engineers needed for process engineering design and economics; pilot plant operations in process development; refinery engineering and process improvement.

Give full and specific details of education, experience, desired salary, availability date, and references.

All inquiries will be considered promptly and held confidential.

ESSO RESEARCH AND ENGINEERING COMPANY
(Formerly Standard Oil Development Company)

Personnel Division
P. O. Box 51 Linden, New Jersey

GULF RESEARCH & DEVELOPMENT COMPANY

Has positions now open for

● **ELECTRICAL ENGINEERS & PHYSICISTS—B.S., M.S.**

Design and development of electronic equipment and instruments for recording and remote reading of deep well pressures, temperature, flow; production, pipeline and off-shore instrumentation, control and automation.

● **MECHANICAL ENGINEERS—B.S., M.S., Ph.D.**

Design and development of mechanical or hydraulic equipment and techniques for drilling and completion of wells; fracturing of earth formations; flow and treatment of well and pipeline fluids.

● **PETROLEUM ENGINEERS—M.S., Ph.D.**

Development of techniques and equipment for drilling and completion of wells; improvement of productivity into boreholes; production methods; fracturing of formations; consolidation of sands; development of thermal recovery techniques, reservoir behavior analysis, uses of pressure and temperature transients.

● **CHEMICAL ENGINEERING—B.S., M.S., Ph.D.**

Development of physical properties, chemical formulations, techniques of treatment and design of experimental equipment for investigation of colloidal fluids used in well drilling; chemical treatment of produced fluids; and other applications of chemical engineering to oil field production problems. Investigation of the chemistry and engineering of in situ combustion techniques for oil recovery; investigation of the pressure-volume-temperature relationships of hydrocarbons and the use of thermodynamical data in the production techniques.

* Positions are permanent
* Excellent working conditions
* Liberal publication policy
* New facilities
* Suburban location
* Excellent advancement opportunities
* Salaries open

Apply in writing to:
Gulf Research & Development Company
P. O. Drawer 2038
Pittsburgh 30, Pennsylvania

READ the CLASSIFIED ADVERTISEMENTS
appearing in this section each month.

MACHINE DESIGNERS

Challenging opportunity for experienced mechanical engineers with creative ability who are capable of conceiving, planning and carrying through to successful completion new and unusual machines related to the field of automation. Good wages plus profit sharing. Close to ideal recreation and vacation spots.

Delos M. Palmer & Associates
Consulting Engineers
4491 Jackman Road
Toledo 12, Ohio

??? INTERESTED IN STRESS & VIBRATION???

Opportunity for MECHANICAL ENGINEER with medium size, well financed Chemical Equipment Manufacturer.

Latest electronic and strain gage equipment.

Must be capable of working on own initiative and have creative ability.

Permanent position with unusual opportunity for growth. Employment not affected by Government Contracts.

Full package employee benefits including Profit Sharing.

Submit complete resumé' marked "Confidential" to:

MIXING EQUIPMENT CO., INC.
Engineering Recruitment
P. O. Box 1370
Rochester 3, New York

engineers

For Work in Aircraft Nuclear Propulsion Field

The next big advance in aviation is nuclear powered flight, a field which offers exceptional possibilities for professional achievement. General Electric now has positions open in this new field:

ENGINEER for preliminary design of major aircraft structures, and the coordination of structural design with power plant design requirements. AE or ME degree with 4–6 years' experience in aircraft design and development required.

ENGINEER for work in thermodynamic and fluid flow aspects of turbine type aircraft engines and components. ME or AE degree with 2 to 6 years' experience in thermodynamics and aerodynamic development required.

Openings in Cincinnati, Ohio and Idaho Falls, Idaho.

Address replies to location you prefer

Aircraft Nuclear Propulsion Dept.

GENERAL ELECTRIC

Att: Mr. W. J. Kelly
P. O. Box 132
Cincinnati, Ohio

Att: Mr. L. A. Munther
P. O. Box 535
Idaho Falls, Idaho

ENGINEERS

needed to do preliminary analysis, design and development leading to the next generation of high-performance nuclear power plants.

Please write to:

A. E. McLean
Nuclear Power Dept.
Studebaker-Packard Corp.
1580 E. Grand Blvd.
Detroit 32, Michigan

ATOMIC ENERGY NEEDS YOUR TALENT

ALCO PRODUCTS, INC., wants additional competent Mechanical Engineers for nuclear power development. The potentialities of this growing field are limitless. YOU can help it grow! YOU can grow with it!

Typical positions available are:

MECHANICAL DESIGN ENGINEER

Experience Required: Minimum of 10 years including design and test of complex mechanisms and mechanical structures.

ASSISTANT PROJECT ENGINEER

Experience Required: 2 to 5 years' design or test of mechanical components.

JUNIOR ENGINEER

Experience Required: None. Also needed are several Mechanical Designers and Draftsmen.

IF INTERESTED please forward detailed resume and salary requirements to:

G. Y. Taylor, Manager
Employee Services Dept.
ALCO PRODUCTS, INC.
Schenectady 5, N. Y.

All replies kept confidential.

marquardt *Announces*

A NEW PROGRAM OF

INDIVIDUAL PROFESSIONAL DEVELOPMENT

for our Engineers

Individual guidance for you by outstanding specialists complemented by company-supported educational programs. Write for details

marquardt AIRCRAFT CO.

Attention: Professional Personnel
Industrial Relations Department • 16550 Saticoy St., Van Nuys, Calif.

THE WEST'S LARGEST JET ENGINE RESEARCH AND DEVELOPMENT CENTER

Attractive living

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Opportunity unlimited

Job security

Engineering challenge

TOP SALARIES

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Electronic Engineers
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Physicists
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Interesting assignments in power plant development in the following fields:

Pumps & Turbines
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Electrohydraulic Systems

Send your resume to:

EMPLOYMENT SUPERVISOR

Dept. ME, Azusa, Calif.

Aerojet-General CORPORATION

A Subsidiary of The General Tire & Rubber Company

THE GENERAL TIRE

AZUSA, CALIFORNIA

SACRAMENTO, CALIFORNIA

DESIGN ENGINEER

Excellent opportunity for a really creative engineer willing to grow into administrative responsibilities. Inventiveness and the ability to be truly objective are the keys to a successful career with a progressive organization having the largest Research and Engineering facilities in the steel valve industry.

Edward Valves, Inc., Sub. of Rockwell Mfg. Co.
East Chicago, Indiana

MECHANICAL ENGINEERS

We need four engineers, preferably with design experience; one is required for steam turbines, one for steam turbine controls, one for centrifugal pumps and one for centrifugal compressors. Design experience is desirable but not absolutely necessary; young engineers interested in these fields, but without specific experience, will be carefully trained. De Laval is a medium sized, long established manufacturing concern. The positions are for our permanent engineering staff. Starting salary and progress will be commensurate with ability. Please submit brief resume of qualifications to:

Personnel Department
De Laval Steam Turbine Company
853 Nottingham Way
Trenton 2, New Jersey

MECHANICAL ENGINEERS...

You'll find professional stimulation in

RCA's AIRBORNE WEAPONS SYSTEMS Projects!

As a mechanical or aeronautical design engineer, you can now grow with RCA's creative engineers on airborne weapons systems. In addition to your bachelor or advanced degree, you should have experience in design of aircraft structure and mechanisms or design of aircraft control instruments.

These RCA problems call for truly advanced effort. You will be challenged by the severe environmental conditions encountered in the supersonic flight of tomorrow's highest-speed aircraft. New concepts in mechanical design are required to deal with previously unexplored states of temperature, altitude, shock, vibration and humidity.

Plus . . . completely equipped engineering laboratories—advancement on merit—full benefits program—relocation expenses paid.

Please send resume of education and experience to:

Mr. John R. Weld, Employment Manager
Dept. B-6D, Radio Corporation of America
Camden 2, N. J.

RADIO CORPORATION OF AMERICA

DEFENSE ELECTRONIC PRODUCTS

Procter & Gamble needs MECHANICAL ENGINEERS

(Graduated within last 10 Years)

- Permanent positions in Mechanical Research and Development, Process Equipment Design and Application, Heat and Power Equipment Design and other Engineering Fields.
- Salaries commensurate with education and industrial experience.
- Opportunities to grow with a leading chemical processing company—rated as one of the nation's three best-managed companies by the American Institute of Management.

For application form and further information write

Mr. J. E. Gale
Head of Employment
Engineering Division
The Procter & Gamble Company
Cincinnati 17, Ohio

ENGINEERS

for immediate placement

ELECTRICAL ENGINEERS
MECHANICAL ENGINEERS
ELECTRONIC ENGINEERS
COMPUTER ENGINEERS
SOLID-STATE PHYSICISTS

Engineering at NCR:

1. Immediate, permanent positions in Mechanical Engineering, Electrical Engineering and Physics Research Divisions.

2. Engineering project work in Adding Machines, Cash Registers, Accounting Machines, Computers and related Data Processing Equipment in Dayton, Los Angeles, and Ithaca, New York.

3. Opportunities in design, development, production-engineering and packaging of mechanical, electronic, and electromechanical devices.

4. Some experience in development, design, and application of high-speed, light-weight mechanisms of the intermittent-motion type; or, experience in digital devices and components, is desirable, but not essential.

5. Ample training and indoctrination is available to all employees.

As an NCR engineer you, with your family, will enjoy:

1. UNLIMITED OPPORTUNITY in the broad, ever-expanding field of Business Machine Engineering and Research.

2. AN EXCELLENT SALARY, plus exceptional benefits of lifetime value for you and your family.

3. A RECREATIONAL PROGRAM for year-round enjoyment of the entire family, including a new NCR Country Club with 36 holes of golf, and a 166-acre employees' park for outings with swimming, boating, and supervised play for the children.

4. LIVING IN DAYTON . . . considered a clean, attractive, progressive city with outstanding school facilities.

5. YOUR WORK AT NCR with its friendly, family atmosphere, with its employee morale at a very high level, and with people who, like yourself, have decided to build their professional future with NCR.

National*

ACT AT ONCE — Send résumé of your education, experience and geographic preference to:

EMPLOYMENT DEPARTMENT, TECHNICAL PROCUREMENT SECTION 2

THE NATIONAL CASH REGISTER COMPANY
Dayton 9, Ohio

*Trade-Mark—Reg. U. S. Pat. Off.

Fort Wayne, Ind.
"America's Happiest City"

Dear Bill:

Now that Joe is on the team here at Farnsworth, he's asked me to write and give you the same story that got him interested in coming with us.

Actually, Bill, it wasn't a "story." Just a few honest-to-goodness reasons why he and Marge should make the move and let the family really live as well as let Joe grow professionally.

For instance, do you know what "sold" Marge? The fact that in living here you are only 10 minutes from everywhere—schools, churches, stores etc. and Joe goes home for lunch every day instead of week-ends. She also liked the idea of some 300 lakes within 70 miles. (Guess where they're planning to spend the summer!)

As for Joe, he's all hepped up about the work he's doing on such missiles as Bomarc, Talos, Terrier and others. Says the top-notch scientists and engineers he's working with are all big-league and he's on the team.

That's about it, Bill. An engineer with your talents shouldn't be waiting around when he can get in on the ground floor here at Farnsworth in research, development or production engineering in missile guidance and control, radar, microwaves, test equipment, counter-measures, transistor applications etc.

So—why not write, right now to Don Dionne, Farnsworth Electronics Co. Fort Wayne, Ind. (A division of International Telephone and Telegraph Corp.)

You, Joe, I and Farnsworth will be mighty glad you did.

Sincerely, Jack

MTM ENGINEER

Background in methods and time study

apply

PRATT, READ & CO., INC.
Ivoryton, Connecticut

Chemical and Mechanical Engineers

Immediate opportunities for engineers interested in designing heat exchangers and pressure vessels for power plant, chemical process, petroleum refining, atomic systems, Navy, Marine and refrigeration applications. A real opportunity to become associated with a growing and expanding company with an outstanding reputation in the heat transfer field. Write to the Manager of Personnel Administration including education, experience, and salary desired.

[redacted]
ROSS HEAT EXCHANGER DIVISION
AMERICAN-STANDARD
1407 West Avenue
Buffalo 13, New York

SENIOR MECHANICAL DEVELOPMENT ENGINEER

With technical education and ten to twenty years of experience or more in design and development of heavy machinery or similar experience, for research and development work both as to design and from industry study points of view. Permanent position with opportunities to grow are involved in expanded program of well-established heavy machinery, rolling mill and hydraulic press builders. Location Pittsburgh. Write complete details of experience, pertinent personal information and enclose photograph in first letter. Salary $10,000 per year or more, depending on experience.
Also opening available for a man with above general qualifications, but having less experience. Salary in proportion.

Address CA-5529, % "Mechanical Engineering."

ENGINEERS

Our South Charleston, West Virginia chemical plant has openings for Mechanical, Electrical or Chemical Engineers to fill the following positions:

SENIOR MAINTENANCE ENGINEER with considerable supervisory experience in chemical plant maintenance work. Must be familiar with up-to-date planning and scheduling methods.

MAINTENANCE ENGINEER with up to five years' experience in maintenance work to set up preventative maintenance procedures, redesign equipment where necessary and give technical assistance in maintenance procedures.

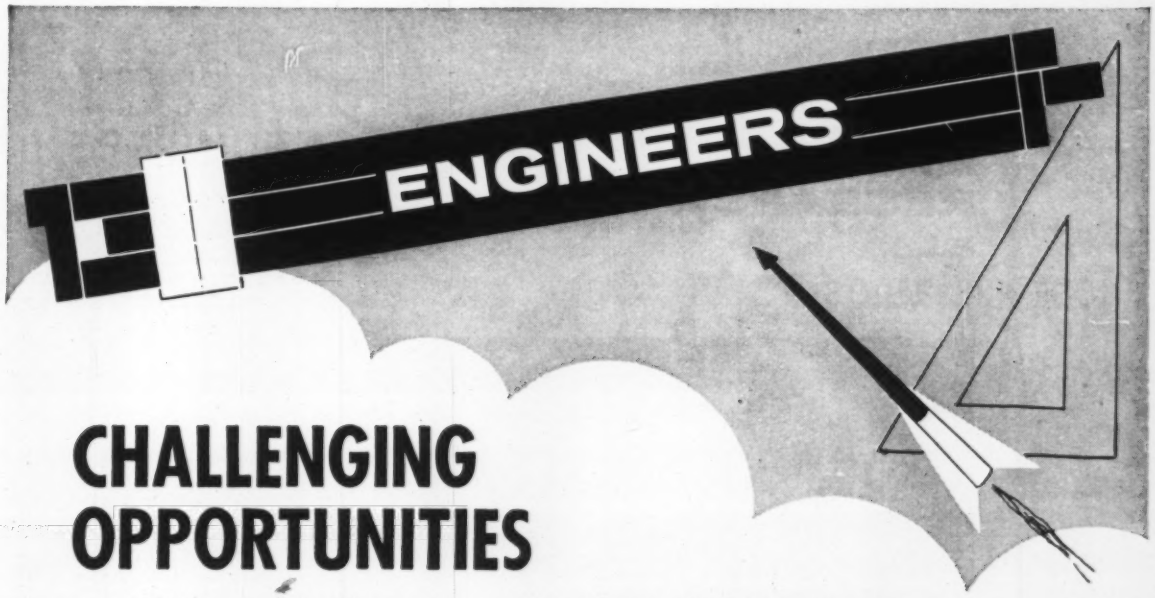
STEAM AND POWER ENGINEERS with up to 15 years' supervisory and/or staff experience in steam and power generation. Two positions are open.

PROJECT ENGINEERS with up to ten years' experience in mechanical and process design required for overall technical supervision of construction projects. Involves supervision from the preparation of engineering drawings to the final completion of a field installation.

This plant produces chlorine, caustic soda, carbon disulphide and a number of related inorganic and organic chemicals.

Please send resume and salary requirements to:

WESTVACO CHLOR-ALKALI DIVISION
FOOD MACHINERY & CHEMICAL CORP.
Drawer 8127
South Charleston, West Virginia
Attention: Department 6



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- **Avionics**
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The men hired will enjoy working with some of the top men in the field and with the finest test, research and development facilities. GM's long-standing policy of decentralization creates individual opportunity and recognition.

Why not send us full facts about your education, work background, etc.
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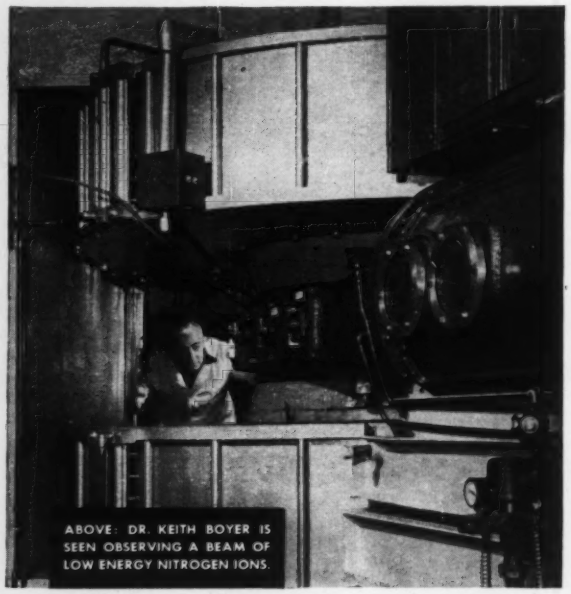
AC SPARK PLUG — THE ELECTRONICS DIVISION
GENERAL MOTORS CORPORATION
MILWAUKEE 2, WIS. — FLINT 2, MICH.

BASIC RESEARCH at los alamos



ABOVE: DR. KEITH BOYER IS SEEN OBSERVING A BEAM OF LOW ENERGY NITROGEN IONS.

The cyclotron shown above is one of the many types of advanced research equipment in use at Los Alamos. This variable energy machine is designed to accelerate high intensity beams of all the hydrogen and helium isotopes.

The Laboratory offers a wide range of opportunities to do research and development work in the fields of Physics, Chemistry, Metallurgy, Mathematics, Computing and Engineering.

If you are interested in learning more about career opportunities at Los Alamos, write—

DEPARTMENT OF SCIENTIFIC PERSONNEL
Division 707

los alamos
scientific laboratory
OF THE UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO

mechanical
or industrial
ENGINEERS

for assembly and fabrication planning, cost estimation, tooling development, time studies.

GROWTH OPPORTUNITIES with General Electric, Utica, New York.

The engineering staff has more than doubled in four years at this ultra-modern plant. Now 10 more highly qualified, mechanical or industrial engineers are needed to plan and help supervise new manufacturing operations. These are unusual positions, with clearly defined promotion opportunities in Advanced Manufacturing Development, Methods Specialization and Supervisory Assignments.

If you have had from 3 to 5 years' experience in methods improvement and related fields, and have the ability to advise on technical engineering problems, we would like to discuss your future with you.

Excellent Starting Salaries
Notable GE Benefit Program
A Fine Location with Homes Available and All-Year Outdoor Sports

write including details of experience to:

Mr. Dan Carroll
Personnel Office
Light Military Electronic Equipment Dept.
GENERAL ELECTRIC
French Road, Utica, N. Y.

ENGINEERS

The APPLIED PHYSICS LABORATORY OF THE JOHNS HOPKINS UNIVERSITY offers an exceptional opportunity for professional advancement in a well-established laboratory with a reputation for the encouragement of individual responsibility and self-direction.

Our program of

GUIDED MISSILE DEVELOPMENT

provides such an opportunity for men qualified in:

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INTERNAL AERODYNAMICS AND PROPULSION
MACHINE SHOP LIAISON AND PRODUCTION
STRESS ANALYSIS

Please send your resume to:
Professional Staff Appointments

APPLIED PHYSICS LABORATORY
THE JOHNS HOPKINS UNIVERSITY
8607 Georgia Avenue
Silver Spring, Maryland

DU PONT

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a continuous flow of

Diversified, Original Assignments

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If you are a talented graduate engineer with 4 or more years' design experience, DU PONT has opportunity for you. Consider this vital fact—our policy is promotion from within.

Apply today to fill one of the immediate openings for—

PROCESS AND EQUIPMENT DESIGNER-ENGINEER

Successful applicants will be capable, either now or with training, of translating research data into workable equipment and process designs. Will enjoy and have ability to work as a part of an engineering design team. Will be capable of handling field design problems which will involve working with shop or construction people. Experience in the design of processes or process equipment for chemical, petroleum, food processing and allied industries, knowledge of ASME Code For Unfired Pressure Vessels, and shop fabrication or piping design practice is helpful but not essential.

Applicants selected will make independent analysis, exercise individual judgment and coordinate the work of others while engineering and designing process equipment including tanks, vessels, distillation columns and machines. Equipment arrangements and piping work will also be included. Assignments are challenging and creative with full recognition for achievement.

POWER DESIGNER-ENGINEER

Experience in the design of industrial plant facilities required to supply utility services to chemical processes is desired. Applicable experience should be in steam generation and distribution, water supply and treatment, refrigeration, fire protection, outside pipe lines, process waste disposal and industrial furnaces.

Successful applicants will design and engineer a variety of the above mentioned facilities as are required by new or existing chemical processes. Work will involve not only economic installations, but also the challenge of meeting special requirements in connection with process problems.

INSTRUMENT DESIGNER-ENGINEER

Experience in the application and installation of instruments for the control of chemical processes is required. Design experience should be in pneumatic and electronic instrumentation for the measurement and control of process variables, including layout of complex graphic type panels.

Successful applicants will design and engineer systems as outlined, giving consideration to economic installations and maintenance features. He will also assist in the development of control diagrams, prepare installation layouts and detailed hook-ups for unique application, write specifications and assist construction personnel in installation problems.

INTERVIEWS IN NEW ORLEANS
May 6, 7, 8, 9 (Sun.-Mon.-Tues.-Wed.)
For appointment, please call
Mr. J. C. Costello, Jr., MAgnolia 2371

Or you may send complete resume, including details of education and experience, to:
Mr. T. J. Donovan
Engineering Department

E. I. du Pont de Nemours & Co., Inc.
Wilmington 98, Delaware

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Non-Aircraft Engineers

Lockheed will train you for various types of aircraft engineering—at full pay

Mechanical Engineers can become
Thermodynamicists
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Civil Engineers can become
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Structures Engineers
Research Engineers in Structures
Design Engineers

Electrical Engineers can become
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Electrical Research Engineers
Flight Test Laboratory Engineers
Flight Test Engineers
Design Engineers

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Promotion Opportunities are excellent because there are so many supervisory positions to be filled with 46 major projects in progress at Lockheed – and because Lockheed is in an expanding development and production program.

Scope for your ability You can show what you can do because Lockheed activities range across virtually the entire spectrum of aeronautical endeavor. You are not limited to one type of work because Lockheed is so diversified in projects. Moreover, Lockheed encourages and welcomes personal initiative.

Salary increase You may receive a substantial increase in pay because Lockheed is extremely liberal in direct salary and in extra employee benefits which actually increase the value of your position by an average of 14%. *Generous travel and moving allowances.*

You are invited to write for a brochure describing life and work at Lockheed and a job application blank. Coupon at right is for your convenience.

Mr. E. W. Des Lauriers, Dept. NA-4-4
Lockheed Aircraft Corporation
1708 Empire Avenue, Burbank, California

Lockheed California Division

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My present field of engineering

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For further information write *OMAR Employment Officer* at the company nearest you.

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- **Aerodynamic Engineers**
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to work on basic loads caused by high performance configurations, specialized missile systems criteria, unique recovery provisions and new environmental conditions associated with many types of advanced missile design.

The positions require an M.S. Degree in Mechanical, Aeronautical or related fields of engineering and at least two years' experience in loads, dynamics or aerodynamics, including transonic or supersonic aerodynamics. Equivalent experience will be considered.

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research and engineering staff

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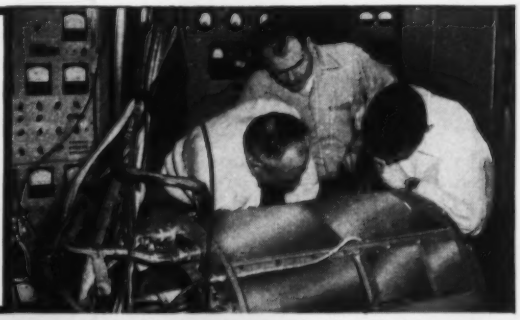

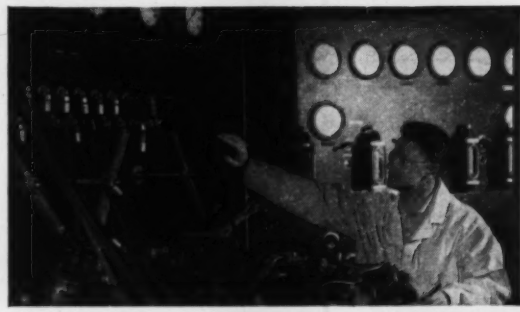

PROPULSION

Engineers are needed to participate in the development and testing of advanced ram-jet engines and systems. Experience in any of the allied fields of fluid mechanics, heat transfer, combustion research, fuels, engine testing, hydraulic systems, turbines, pumps and engine instrumentation is desirable.

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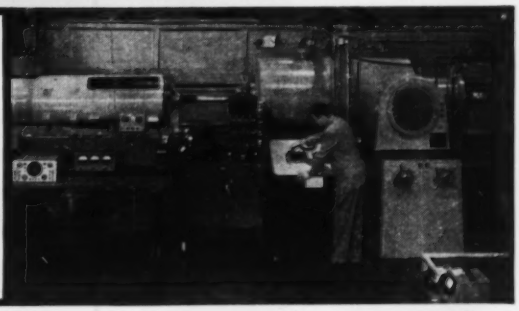

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Desired qualifications will include extensive engineering knowledge of and familiarity with equipment used in the fluid mechanics field. Development, research, design, maintenance, or teaching experience with pumps, compressors, jets, and seals is desirable. Responsibilities of the position will involve selection of equipment, trouble-shooting, and consultation on fluid flow and mechanical design aspects of piping, pumps, jets, compressors, and seals. Duties include evaluation of available equipment and recommendations for equipment modification for special applications.

2 POWER

Position requires extensive practical power experience including operation and maintenance of industrial steam power plant facilities and equipment testing. Some experience in steam plant design and construction or in thermal insulation of process piping and equipment is desirable. Duties include: making economic evaluations and involved heat balances for complicated power systems; assisting in specification of power equipment and in selection of new facilities; and determination of causes of equipment malfunctioning and development of recommendations for corrections.

3 MATERIALS HANDLING

This position requires three to ten years experience with bulk or package handling systems and equipment. The successful applicant will be expected to have engineering knowledge of belt conveyors, bucket elevators, screw conveyors, storage bins, chutes, hoppers, and feeders. Familiarity with pneumatic conveyors or mobile handling equipment is desirable. Duties include providing consultation on existing equipment, selection of new equipment, making cost studies, and development and execution of major materials handling engineering programs.

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5 EQUIPMENT IMPROVEMENT

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Mr. J. C. Costello, Jr.
Engineering Department

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Challenging careers are open to qualified

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Power is Combustion's business, whether the heat source be conventional or nuclear fuels. For nearly three-quarters of a century, C-E has been designing and manufacturing equipment for the generation of steam to produce power. A decade ago, it moved naturally into the nuclear power field. And now, with the new facilities under construction and completed at its Chattanooga plant – and the soon-to-be-completed Center at Windsor – Combustion is uniquely qualified for a leading role in the atomic power industry.

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- Development, design, manufacture, tests on rotating and reciprocating machinery, stress analysis, bearings, lubrication, thermodynamics, aerodynamics, fluid flow and kinetics combined with mechanical aptitude and natural ability.
- Young mechanical engineer to learn design of welding and cutting apparatus. Experience and interest in design of small parts. Will also supervise manufacture and test of experimental designs.

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Mechanical or chemical engineers with major experience or interest in chemical or process equipment and plants design and construction. Practical application of thermodynamics, fluid flow, heat transfer, distillation, fluid separation processes, piping control and instrumentation combined with strong mechanical sense and ability to coordinate a project from contract to completion.

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Senior engineer to supervise and design pressure vessels of carbon and stainless steels, aluminum and copper to ASME Code. Must be thoroughly familiar with codes. Welding details, and manufacturing methods.

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Self-energising young engineer to participate in large scale contract negotiations with engineering and management personnel.

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Highest salaries commensurate with training, and experience. Profit sharing and other benefits. This is an excellent opportunity for engineers with above average ability and initiative to progress in the rapidly expanding new field of low temperature processing. Applications will be treated in strict confidence and should be complete—education—experience—interest and other information which will help us to understand and evaluate you. Write to B. H. Van Dyke.

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- **stress analysis**

These projects are associated with the production and distribution of oxygen, nitrogen and argon as low temperature liquid or gases.

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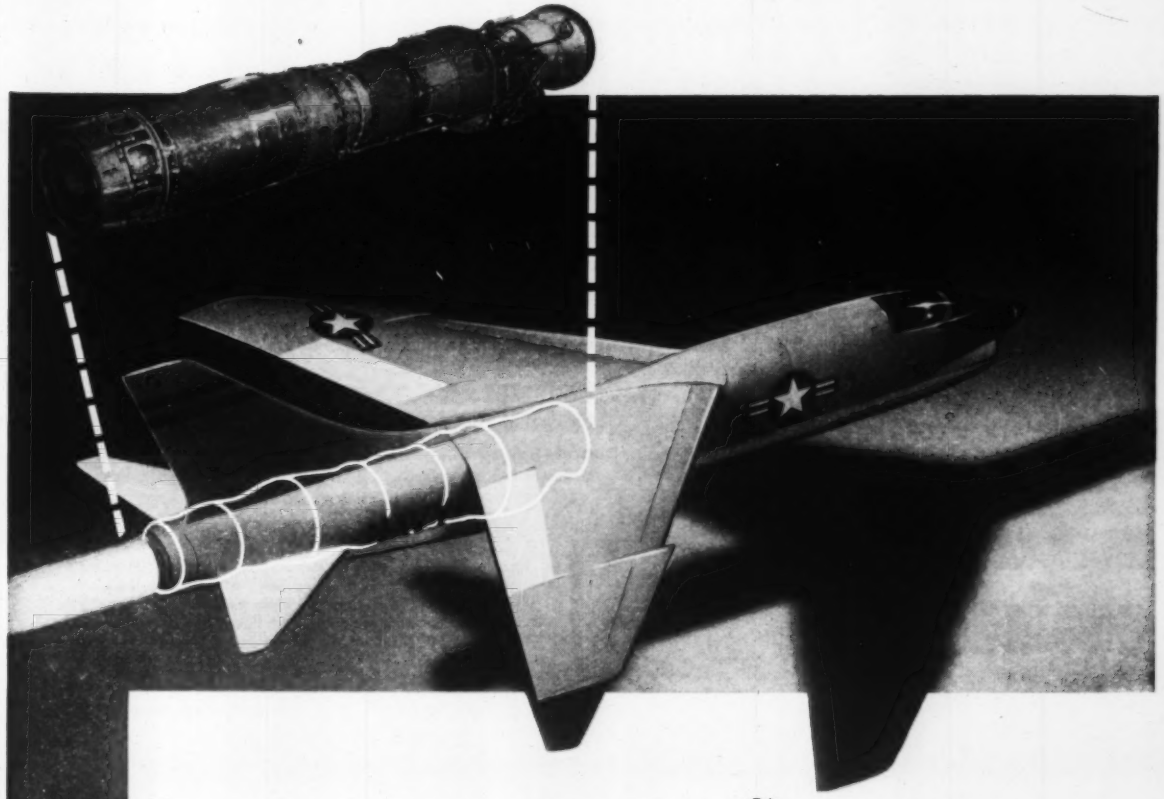

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- ***Controlled Duct Airflow Without the Complication of Variable Inlet Structure***
- ***Negligible Cooling Drag***
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MECHANICAL ENGINEER—on railroad located in central region. Steady employment with opportunities for advancement with progressive organization. In reply state age, experience, and salary expected. Address CA-5600, care of "Mechanical Engineering."

PROJECT ENGINEERS—Experienced senior and associate project engineers for design and development of special field machinery for the Sugar Cane Industry in Hawaii. Previous experience in the design and development of construction or agricultural machinery important. Address CA-5606, care of "Mechanical Engineering."

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ENGINEER—Chemical or Mechanical, with several years' experience in the selection, layout, and installation of chemical equipment. We are looking for a mature, responsible individual who, in addition to technical qualifications, possesses the necessary resourcefulness and aggressiveness to see through to completion, each assigned project. Work involves some maintenance of chemical equipment as well as designing and relocating installations. Address CA-5627, care of "Mechanical Engineering."

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SALES ENGINEER—Established company in Western New York requires graduate in mechanical engineering for sales development. Expansion of our product line has created this opening and offers challenging opportunities for a young man to grow with the operation. One to four years' experience in metal fabrication and finishing, including some sales experience, is desirable. Please submit full details of qualifications and draft status with first reply. Our employees know of this advertisement. Address CA-5631, care of "Mechanical Engineering."

Florida Consulting Engineering firm needs *experienced* Mechanical, Electrical and Civil Engineers and Draftsmen for permanent positions to do Industrial and Commercial design projects. Give outline of experience, references, available date and starting salary. deLaureal & Moses, Inc., 7 W. Intendencia Street, Pensacola, Florida.

PROPULSION ENGINEERS—The Theoretical Propulsion Group is now being organized at Chance Vought Aircraft, Incorporated, and numerous new openings are available at many levels for qualified propulsion engineers with a B.S. degree and two or more years' experience or an advanced degree and no experience. The work in this group is devoted to over-all aircraft propulsion systems and system components including all phases of prop, jet and nuclear propulsion and in general is dedicated toward obtaining an optimum marriage between a propulsion system and an airframe. More specifically the work deals with such topics as engine inlets and outlets, internal cycle analysis, over-all propulsion system analysis and relative merits, heat transfer, environmental gas conditioning, and high energy fuels. Timewise, the work deals with aircraft propulsion systems from today to ten years in the future. These openings offer unique opportunities to analytical, design and development propulsion engineers to broaden themselves by working with over-all propulsion systems as applied to flight vehicles and later to rotate on an optional basis into groups doing propulsion project work or preliminary aircraft design work. Salaries are commensurate with qualifications and are at the premium level. Address resume or further inquiry to: Dr. W. J. Hesse, Supervisor—Theoretical Propulsion Group, Chance Vought Aircraft, Incorporated, P.O. Box 5907, Dallas, Texas.

INSTRUCTOR of Industrial Engineering—Bachelor's degree in Industrial Engineering or I.E. option of Mechanical Engineering plus four years' industrial engineering experience. ASSISTANT PROFESSOR of Industrial Engineering—Master's degree in Industrial Engineering plus four years' industrial experience and two years' teaching experience. Salaries commensurate with education and experience. Both positions offer graduate study, research and summer employment opportunities. Department of Industrial Engineering, Syracuse University, Syracuse 10, New York.

TEACHING POSITIONS in civil, mechanical engineering, beginning September, 1956. Salary and rank open. Apply Administrative Dean, Fresno State College, Fresno 4, California.

ELECTRICAL ENGINEER with degree, for large paper mill operation. To take charge of High Pressure Power Plant, Electrical and Pipefitting Department. Work involves operation, maintenance, installation and related engineering. Heavy boiler experience desirable. Salary open. Age about 35. Location—Pennsylvania. Address CA-5531, care of "Mechanical Engineering."

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POSITIONS WANTED

TEACHING POSITION—Ph.D. in M.E., age 32, 12 years of industrial, research, and teaching experience. Good background in thermodynamics, and fluid mechanics with publications. Desires responsible position with research opportunities to help develop courses in undergraduate and graduate levels. Available September. Address CA-5584, care of "Mechanical Engineering."

MECHANICAL ENGINEER—42, registered Ohio: Wants position in project or development engineering. Work history includes power plant operation, six years' teaching physics, and presently in research and development of combustion, steam generation and control equipment. Well versed in laboratory technique and instrumentation. Address CA-5609, care of "Mechanical Engineering."

MECHANICAL ENGINEER—34, BSME, seven years' varied experience with major oil company refinery making designs for modifications and additions. Desires better opportunity to enlarge experience and professional standing. Address CA-5614, care of "Mechanical Engineering."

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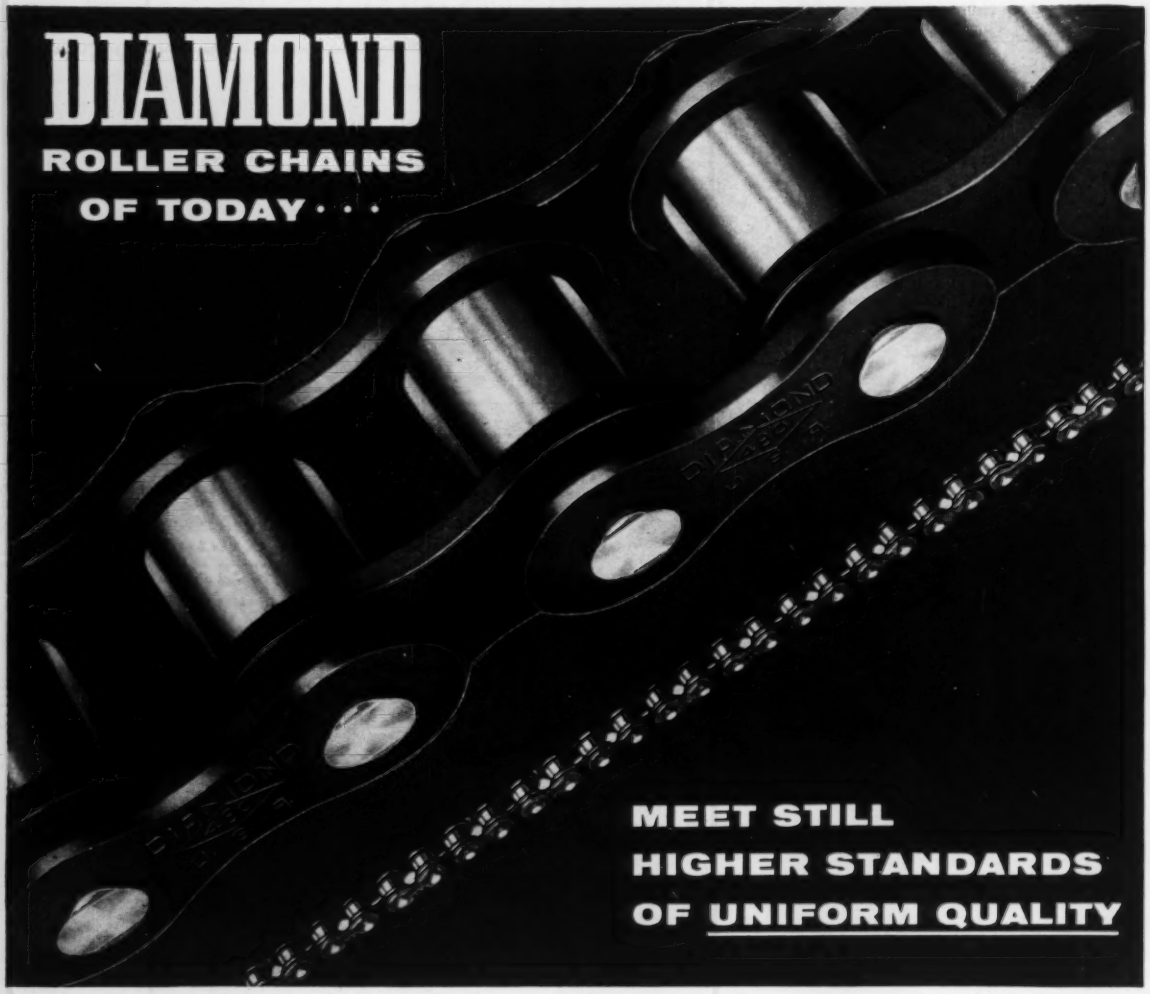
It will pay you to watch the announcements on these pages for an opportunity that you may be looking for or one that may be of interest to you.



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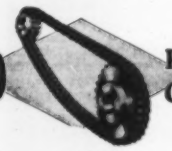

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says Leonard Schaffer, President, Mechanical Art Works, Inc., Newark, New Jersey

A few typical fine-finish, close tolerance screw machine products currently produced from ANACONDA Rods at the Mechanical Art Works.

"The tremendous versatility of automation in modern manufacturing has placed a bigger burden on the designer and buyer of screw machine parts," Mr. Schaffer explains. "The trend toward miniaturization has shifted many more parts to the screw machine. And the screw machine's ability to provide *tolerances* as close as .0005", and finishes heretofore obtainable only by centerless grinding, has left a tremendously wide choice in specifications."

Mr. Schaffer, a long-time user of Anaconda products, says, "I can count on the uniform machining characteristics of ANACONDA Rods from batch to batch, which is important for both quality and economy in my business."

For complete data on composition and machinability of standard ANACONDA Alloys, standard specifications, weights and dimensions of standard rods, write for Publication B-14. Address: The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont. 5583

A few of Mr. Schaffer's suggestions to buyers of screw machine products for keeping costs down.

Wherever possible, the largest diameter of the piece should correspond to a standard stock rod diameter.

Avoid fancy shapes calling for expensive forming tools.

Use hole diameters obtainable with standard tools.

Allow commercial tolerances if possible, otherwise specify tolerances no closer than necessary.

Specify Standard National Coarse or National Fine Threads wherever possible.

On external threads, cutting full threads close to a shoulder is expensive —and may be unnecessary.

Tapping blind holes close to the bottom is difficult and costly.

Specify free cutting material unless special physical properties are required, then select the best machining material containing those properties.

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An intrstng exprmnt in spch

Some day your voice may travel by a sort of electronic "shorthand" when you telephone. Bell Laboratories scientists are experimenting with a technique in which a sample is snipped off a speech sound—just enough to identify it—and sent by wire to a receiver which rebuilds the original sound. Thus voices can be sent by means of fewer signals. More voices may economically share the wires.

This is but one of many transmission techniques that Laboratories scientists are exploring in their search for ways to make Bell System wire and radio channels serve you more efficiently. It is another example of the Bell Telephone Laboratories research that keeps your telephone the most advanced on earth. *The oscilloscope traces at right show how the shorthand technique works.*

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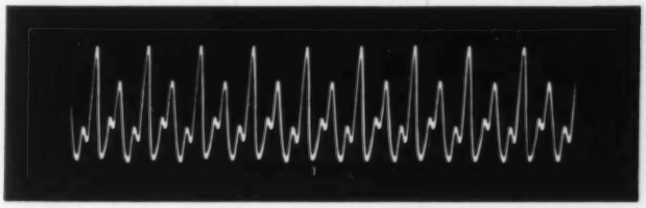
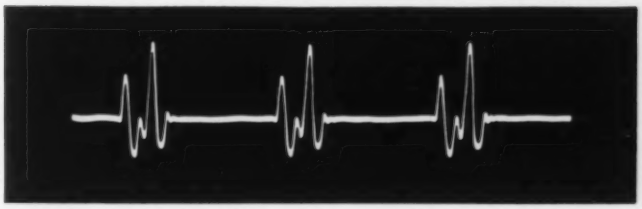
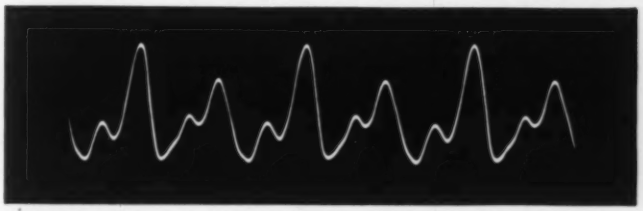
Largest industrial laboratory in the United States



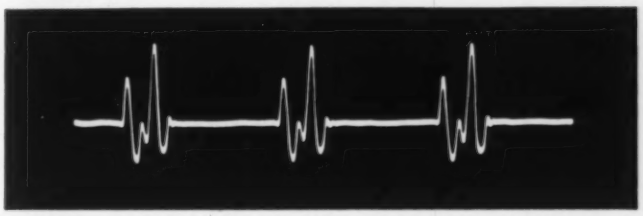
Vibrations of the sound "or" in the word "four." Pattern represents nine of the "pitch periods" which originate in puffs of air from the larynx when a word is spoken.



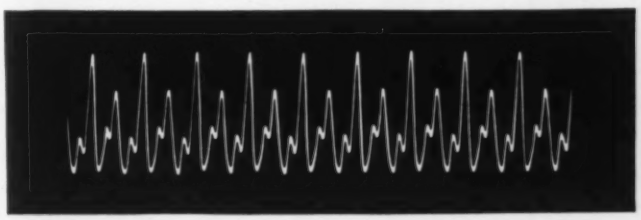
An electronic sampling of the "or" sound. One "pitch period" in three has been selected for transmission. This permits great naturalness when voice is rebuilt. Intelligible speech could be sent through a 1 in 6 sampling.



The selected samples are "stretched" for transmission. They travel in a narrower frequency band than complete sound.



Using the stretched sample as a model, the receiver restores original frequency. In all speech, sounds are intoned much longer than is needed for recognition—even by the human ear. Electronic machines perform recognition far faster than the ear.



The receiver fills in gaps between samples, recreating total original sound. Under new system, three or four voices could travel at once over a pair of wires which now carries only one—and come out clearly at the end!

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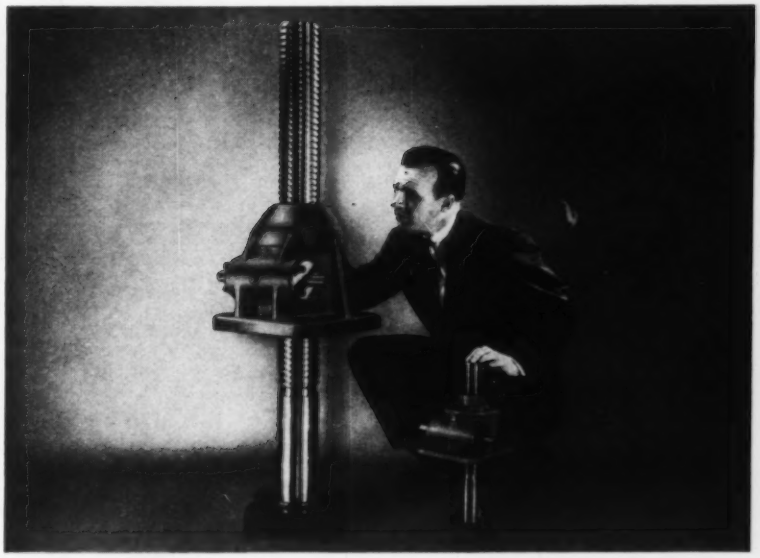

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. . . with *union* body-bonnet joint on 125 lb., 150 lb., 200 lb. pressure classes

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Forms metal by new cold flowing process–TIMKEN® bearings assure wall thickness within ±.002″

FLOTURN, a radically new metal-working process developed by Lodge & Shipley, applies continuous pressure to a metal blank, forming it to the shape of a mandrel. It's an extremely accurate process. Even under heavy loads at high speeds, this L & S No. 40 FLOTURN Lathe holds wall thickness tolerances to ±.002″.

One big reason for this accuracy is the Timken® tapered roller bearings on the spindle. The tapered construction of Timken bearings lets them take the heavy radial and thrust loads in any combination—holds the spindle in rigid alignment. And line contact between the rollers and races of Timken bearings gives them extra load-carrying capacity — important since the metal is shaped by very high pressures.

Timken bearings practically eliminate friction, saving power. The geometrically correct design of Timken bearings gives them true rolling motion; their accuracy lives up to that design.

Under normal usage, Timken bearings last the life of the machine tool. One reason is that they're made of Timken fine alloy steel. We have to make the steel ourselves, because that's the only way we can completely control quality. We're the only American manufacturer that does.

Whatever machine tool you build or buy, be sure it's equipped with Timken tapered roller bearings. Always look for the trade-mark "Timken" on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

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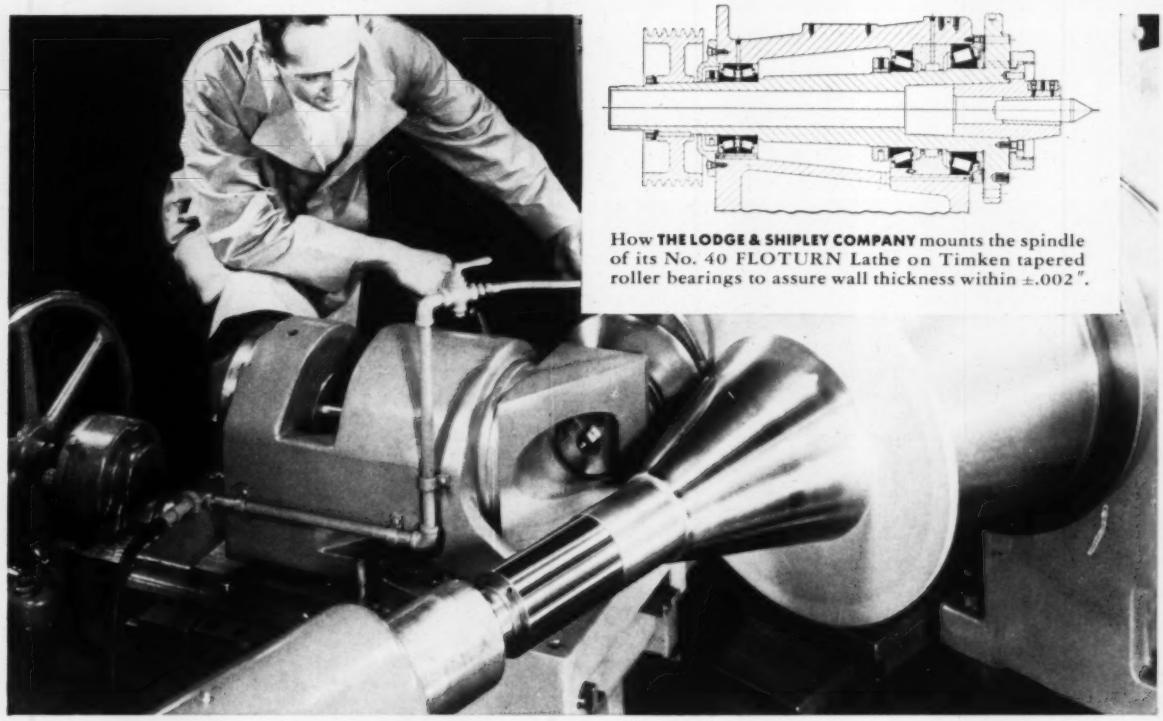
This symbol on a product means its bearings are the best.



How **THE LODGE & SHIPLEY COMPANY** mounts the spindle of its No. 40 FLOTURN Lathe on Timken tapered roller bearings to assure wall thickness within ±.002″.

PROFILOGRAPH TRACE, GOOD COMMERCIALLY GROUND FINISH (5,000 X VERTICAL, 30 X HORIZONTAL)

PROFILOGRAPH TRACE, TIMKEN BEARING FINISH (5,000 X VERTICAL, 30 X HORIZONTAL)

OPTICAL FLAT, PERFECT FINISH

SMOOTH TO MILLIONTHS OF AN INCH

Surface finish of high quality Timken bearing rollers and races is so smooth that it takes a profilograph to measure its smoothness. This instrument measures surface variations to a millionth of an inch, as shown at the left.

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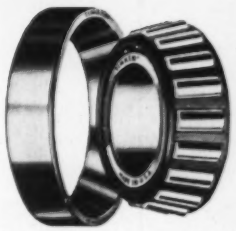

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